AUTOMATION

DECEMBER 1956

POWER OF AUTOMATION

New Horizons in Labor Dignity

The Magazine of Automatic Operations

- Controlling Motor Speeds
- Remote Weight Transmission
- Pushbutton Metal Treating
- Using Meter-relays

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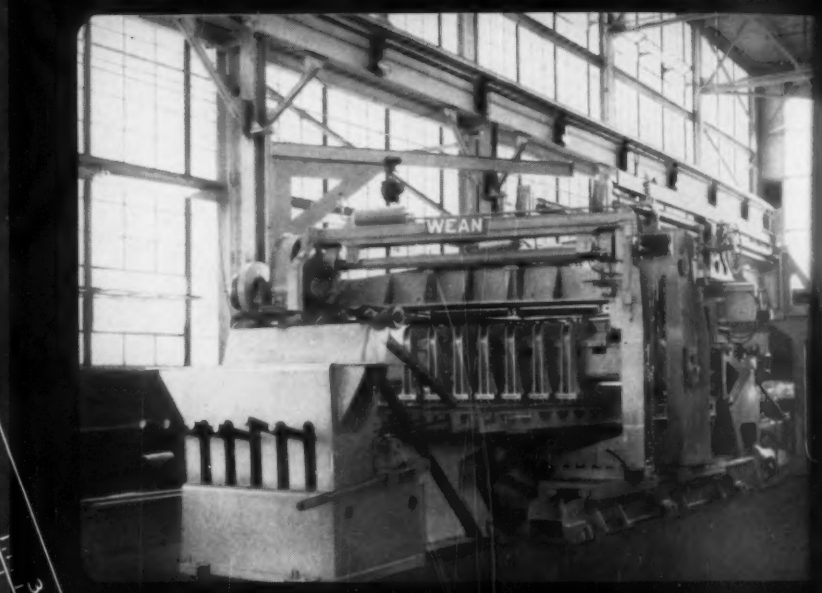
A PENTON PUBLICATION

need an idea?

Wean Trapezoidal Shear Line Solves Problem for Auto Maker



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DECEMBER 1956
Vol. 3—No.12

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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automation outlook

EMANCIPATING MAN FROM THE MACHINE

". . . let us examine the various stages of emancipation of man from the machine and keep in mind that most of this has happened during the past 50 years.

"The *first stage* was the adoption of auxiliary power devices such as hydraulic or pneumatic cylinders, solenoids, pilot motors, etc., with remote control to extend the reach of the human operator and to provide the motive power to actuate the controlling device within the required time. The *second stage* was the application of measuring instruments which would display the necessary operating information for guidance of the human operator. The *third stage* was the coupling of measuring instruments to auxiliary power devices to provide automatic control of repetitive functions. Next came the concept of feedback of intermediate and final output signals to improve automatic control performance. The *fourth stage* was the integration of remote controls, automatic controls, measuring instruments into a common control center for the entire process or plant so that over-all performance could be better supervised by fewer men. The *next stage,* which is still in process of development, is the addition of more complete and more precise instrumentation and of automatic data-processing equipment for further improvement in production efficiency and product quality.

"While most of the industries engaged in the conversion of our natural resources to more useful forms have been advancing according to this program in this twentieth century, the two industries which have probably made greatest progress are those engaged in petroleum refining and in steam-electric power generation . . ."—*P. S. Dickey, president, Bailey Meter Co.*

AUTOMATED INDUSTRY IS ALL INDUSTRY

". . . this remains true even though no industry will ever fully satisfy the drafting board idea of full automation and some industries will satisfy the ideal only in token respects. But all industry will adopt the automation concept of integration and all industry will participate in the automation process of mechanical production and control . . ."—*Adam Abruzzi, professor of industrial engineering, Stevens Institute of Technology,* *see page 38.*

REDUCE VARIETY

". . . automation, whether expressed in the form of an electronically controlled plant or in the form of transfer machines, will yield the most economic results only when the variety of parts, materials and even tools is reduced to a minimum. Simplification and standardization, are, therefore, essential features of the automatic factory . . ."—*R. S. Geoghegan, director, E. G. Brisch & Partners Ltd.,* *see page 48.*

EXECUTIVE THINKING

". . . a planned assembly equipment program, based on a comprehensive survey of present and probable requirements and available methods should be part of every executive's thinking . . ."—*Kenneth R. Treer, Gray Equipment Co.,* *see page 55.*

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AUTOMATION news

Today's events and developments in the field of automation

Key Industrialists Gather To Discuss Automation

INDUSTRY'S dynamic interest in automation was evidenced by the turnout at the First Manufacturing Automation Conference held at Purdue University during October. Over 200 representatives from a wide variety of businesses attended the three-day conference cosponsored by Purdue University and AUTOMATION Magazine.

From comments by conferees and the types of questions asked during discussion periods, it is apparent that a broad segment of industry in general has embraced the concept of automation as both desirable and necessary to improve production operations. Volume producers are actively engaged in expansion or improvement programs which include automation; their need is for detailed answers to automation problems involving equipment, methods and processes. Other industries are aware of the possibilities and are searching for help to guide them in establishing sound automation programs suitable to their special requirements.

MEMBERS of the Manufacturing Automation Conference Planning Committee, Professor E. S. Ault, School of Mechanical Engineering, Purdue University; K. E. Glancy, Div. of Adult Education; and R. W. Bolz, editor, *Automation*, are shown talking to H. R. Blackburn, supervisor, Plant Layout & Facilities Design, and E. A. Damm, supervisor, Tool Planning, both from Whirlpool-Seeger Corp.

Two fundamental problems stand out: On one hand there is a great need for an interchange of ideas and information on the economic considerations of automation. Involved are such factors as classifying and proportioning of costs as direct labor ceases to be a dominant consideration; overall evaluation of alternates in planning; fair economic comparison of existing and proposed facilities, etc. The second problem involves the selection and procurement of the means of implementing plans. Considerations range from small parts feeders to large transfer machines; the means of power and control cuts across the fields of electronic, electric, mechanical, pneumatic and hydraulic technology—in short the problem is not a simple one: Future Manufacturing Automation Conferences will be designed to aid in the solution of these types of problems.

AFTER-DINNER speaker H. R. Bentley, manager, Production Planning, Engine Div., Chrysler Corp. described his experience in developing a complete automated plant. Among those shown around Mr. Bentley after his talk are: J. A. Newton, factory manager, Valve Div., Thompson Products Inc. and A. A. Highland, General Electric Co.

Continually reaffirmed audience interest in several pertinent points indicated the horizontal aspects of automation. For instance, apparently most companies have passed or are passing through a stage where only a few key people are really cognizant of the broad social and technical implications con-

tained in the philosophy of automation. This leads to fundamental problems of communication and organization within a company to bring others up to the same level of understanding. Key questions asked by conferees illustrate this —"How do you obtain the requisite co-operation between the manufacturing and design groups? How do you get employee acceptance for changes? Where does the automation section fit into the organization chart?" In answer to these questions, various speakers told of their own experiences, which in effect boiled down to practices which are accepted today as standard in solving organization or communication problems: Examine thoroughly, plan carefully and implement with firmness and consideration of the individual human problems involved. Employee relations is still a big problem made up of as many individual pieces as there are individuals involved. Technical and economical problems are still solved by careful consideration of as many pertinent details as can be gathered, correlated and co-ordinated. The key point is co-ordination which in automation cannot be on a hit or miss basis.

PERIODS between talks were also utilized for exchange of ideas. One of the speakers, G. W. Jernstedt, (center) director of Manufacturing Engineering Laboratories, Westinghouse Electric Corp., talks with H. L. Kegler, design and automation supervisor, PEMD Staff, Ford Motor Co.; R. J. Emmert, executive in charge, Facilities and Process Activities, General Motors Corp.

MODEL of NATCO transfer line attracted considerable attention during evening get-together. Shown are: A. B. Williamson, plant manager, Bearing Div., McGill Mfg. Co.; R. D. O'Neil, assistant manager, American Blower Corp. Hydraulic Coupling Co.; W. Soper, Designers for Industry; G. E. Rich Jr., industrial engineer, Rich Mfg. Corp.; R. W. Green, industrial engineer, Standard Railway Equipment Mfg. Co.; E. S. Morey, foreman, Bausch & Lomb Optical Co.; and C. F. Kester, manufacturing engineer, Ward Products Corp.

TABLE arrangement at luncheons facilitated further discussion of day's talks and interchange of ideas among conferees.

In other cases, questions relating to policy in extensive purchases of equipment highlighted an issue of vital importance to all industries engaged in implementing automation programs. Several points were made: Time, effort and expense of equipment designers and consultants in preparing preliminary studies or estimates are too extensive in automation projects to be offered on a gratis basis. Responsibility of both supplier and purchaser in fixed price quoting on unique systems must be redefined. More intensive co-operation between purchaser and supplier is necessary during the debugging stage of an installation.

One piece of major advice given by several speakers, which appears to hold good in all cases, was the urging that caution be exercised in entering into automation programs. This advice may have been stated another way—plan carefully and thoroughly—but the underlying meaning was the same. There is no single place where a company can buy a "pound" of automation. An automation program can be successful only if all of the related considerations are fitted together to form a complete picture upon which to base decisions. "Automationitis" is good if top management is the one with the disease and has the presence of mind to search for a cure in the objective manner which is normally applied to management problems. "Automationitis" in the middle ranks must be passed upwards, for in the long run the only effective cure can come through the type of co-ordinated approach top management is capable of organizing.

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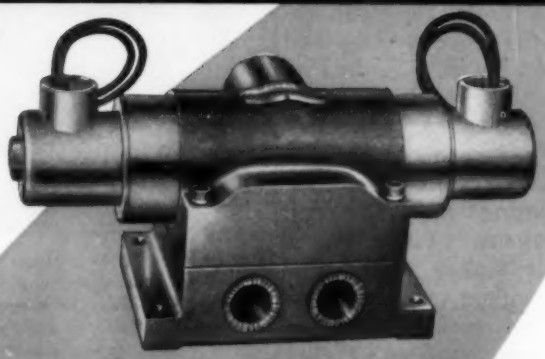

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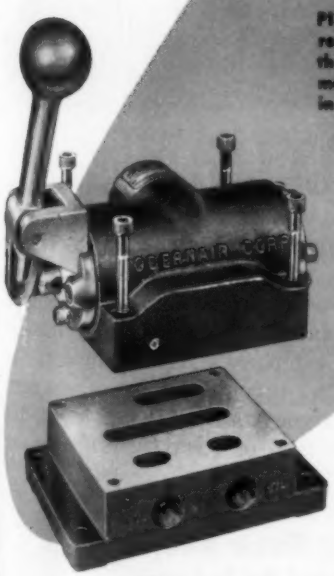

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To Produce Sorter-Readers For Data Processing Systems

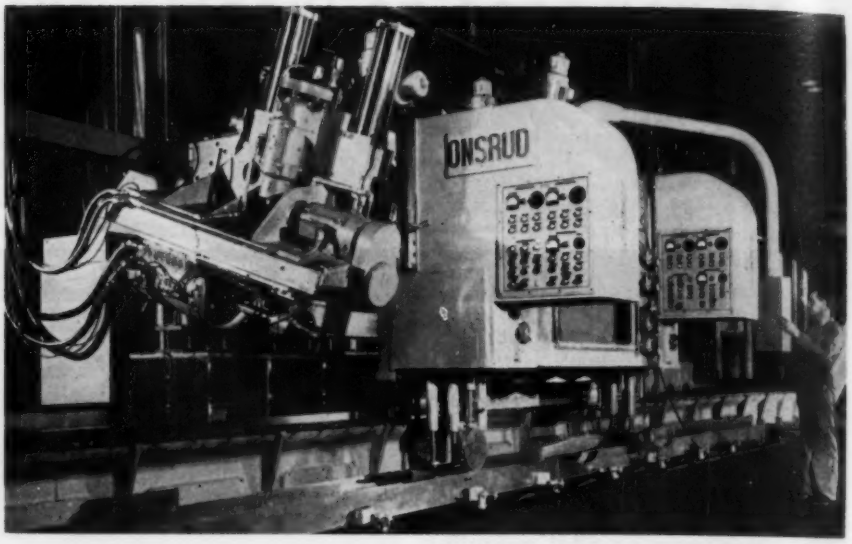
AN AGREEMENT has been reached between the National Cash Register Co. and Pitney-Bowes Inc. whereby they will co-operate in the development and production of sorter - readers of checks and other original forms for use in connection with electronic data processing machines. National Cash Register manufactures accounting machines and business systems. Pitney-Bowes is a leading maker of postage meters and mailing machines, and also builds and markets a line of counting, imprinting and other special business machines.

The sorter-readers which will be manufactured are expected to operate at speeds up to 750 items per minute and will electronically read data printed or coded on checks and other original business forms, not only for the purpose of feeding the information into accounting machines, but also in order to sort the original material as may be desired. Punched cards or tape, usually prepared from original forms, are the only generally used mechanical means of accomplishing these purposes at present.

Under the agreement, Pitney-Bowes will build the mechanical portion of the sorter-reader equipment and National Cash Register will equip the items with electronic reading heads and processing units, and market the complete sorter-readers.

The first sorter-reader machines will be supplied to the General Electric Co. for inclusion in the latter's extensive ERMA data handling system for the Bank of America.

FORMATION of the A. O. Smith Engineering Service Corp. has been announced by **F. S. Cornell,** executive vice president of the A. O. Smith Corp. The new company will supplement the engineering programs now carried on by the 12 operating divisions of the parent corporation and will, in effect, provide supplemental engineering assistance to the engineering staffs of the operating divisions. President of the new company is **D. W. Sherman,** formerly executive engineer of A. O. Smith Corp. The new company will also undertake long-range engineering design programs exploring the automobile frame of the future, consistent with A. O. Smith's position as a leading supplier of frames to the automotive industry. In addition, its services will be available to customers and clients other than the parent corporation.



ELECTRONIC tracer controlled milling machine for aircraft spar production has been designed and produced by Onsrud Machine Works Inc. General Electric Co. developed the control system for the giant miller. The milling machine contains four spindles, each with three available motions controlled by separate templates. Feed motion and template follower head are connected electrically through a selsyn system. Machine is capable of providing repeat cuts to accuracies of 0.002-inch at production rates as high as 300 inches per minute carriage feed and 30 inches per minute head feed.

Research In Small Firms

SMALL business firms can make research pay for itse'f if they keep their objectives modest, according to **J. O. Bengston,** president of Chicago Apparatus Co. It is his opinion that a research laboratory investment as low as $5000 can pay off for many companies. The important thing is to work toward a specific target such as new production techniques or lower maintenance costs. On the other hand, the small firm that hopes to develop an entirely new product is taking a substantial risk.

Bengston points out that in the last 25 years the average dollar invested in science returned a dividend of $60. The return will be as great or greater in the next 25 years and the small company must get its share of this type of investment.

Laboratory projects which can be made to pay off for a typical small company are: Lowering the cost of production, decreasing maintenance costs of old products, increasing the useful life of existing products, and expanding markets for old products by improving their utility, quality or appearance.

APPOINTED to the newly created office of vice president in charge of manufacturing of the E. W. Bliss Co. is **A. S. Burgoyne.** He will be responsible for co-ordinating and directing the activities of the company's 12 manufacturing plants throughout the country. Burgoyne was previously with the Gage Div. of Pratt & Whitney Co. Inc.

More Throw-Away Tools Wanted By Industry

SPONSORED by the Wesson Co., producers of carbide tools, a survey has been taken which reports a trend in industry toward the use of throw-away tools. Apparently, at the present, 15 per cent of all single-point tools used in metal-working are of the throw-away

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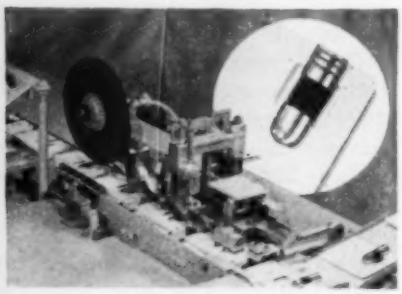
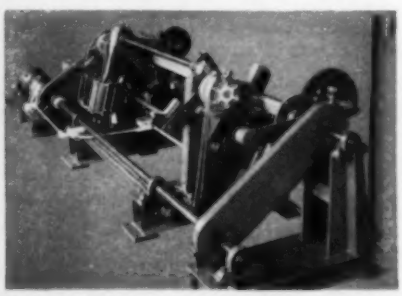
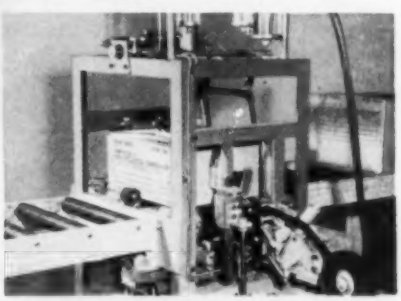


TAPE small items to display cards with a "SCOTCH" Brand Tape Stapler, (dramatized by Artzybasheff at left). Operates at speeds up to 80 units a minute; handles a variety of "SCOTCH" Brand Tapes.



BUNDLE heavy conduit, rigid wall pipe, bar stock at rate of 3 bundles a minute. Machine automatically wraps "SCOTCH" Brand Filament Tape—the world's strongest tape—around both ends of bundle.



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variety. According to the survey, this figure should shortly reach 40 per cent of the total used.

Chief reasons given for the trend appear to be the several indirect cost reductions which throw-away tooling makes possible. Maintenance of extensive and costly tool grinding facilities becomes less necessary. Operators skilled in tool grinding are getting harder to find and more costly to train. In addition, the throw-away tools require less elaborate setups on machines. As a result, machine downtime for tool changes is greatly reduced, thus producing major overall economies—particularly on automated or semiautomated production lines.

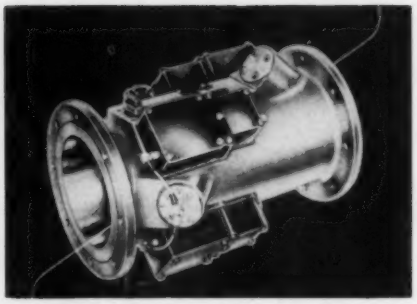
The survey also shows that industry is even more interested in the idea of adapting the throw-away principle on a broad scale to milling cutters and other more complex tools, such as boring tools. This is due to the desire to eliminate grinding which is more complex and costly on milling and multidiameter cutters than on single-point tools.

The industries covered by the Wesson-sponsored survey included manufacturers of ordnance, fabricated metal products, machinery—both electrical and nonelectrical—and transportation equipment.

DETROIT engineering and sales offices of the National Automatic Tool Co. now occupy new quarters at 14119 Puritan Ave. NATCO's new facilities are intended to better service the automation needs of the area. **J. P. Olszewski** is chief engineer of the Detroit engineering division. **H. E. Nelson** is Detroit sales manager.

Company Organized Conference Co-ordinates Automation Efforts

FOR THE BENEFIT of key manufacturing and engineering personnel, International Harvester Co. staged a special two-day conference with the theme "Progress through Automation." Conferees were drawn from various plants



SIMULTANEOUS readout of mass flow rate, mass totalization, volumetric flow rate, volumetric totalization, and fluid density can be obtained in a direct-reading instrument designed to measure fluid flow by utilizing ultrasonic energy. Developed by Maxson Instrument Div., W. L. Maxson Corp., the ultrasonic flow meter determines the volume or the mass of fluid passing through a smooth bore sensor that interposes no obstruction to free flow of the fluid. The illustrated instrument will handle up to 720,000 lb or 90,000 gallons of jet fuel per hour at an accuracy of 1 per cent. Accuracy is independent of changes in fluid density. The unit, which contains no moving parts, operates equally well for either direction of flow and over wide temperature ranges.

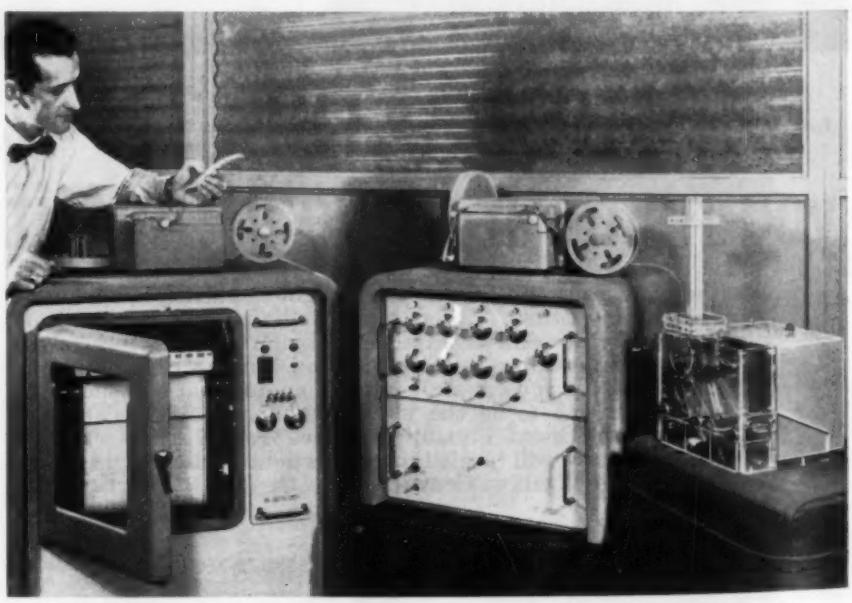
of the corporation. They were given the opportunity to hear the views of top men within and outside the corporation as well as inspect a series of displays which demonstrated automation in action.

Specifically, the goals of the conference were to: (1) Exchange information between technical and managerial people of all divisions; (2) insure that these men are fully acquainted with management-level thinking about automation; (3) provide a review of recent advances in manufacturing facilities, particularly in the area of automation; and (4) provide thought-provoking sessions to stimulate new ideas and interest on the part of each participant.

R. C. Archer, vice president, manufacturing, addressed the group. He stressed that the degree to which automation is applied depends upon prodution requirements and design stability. This means that partial automation may provide the greatest potential benefit in some cases. Stressed, too, was the necessity of close liaison between manufacturing and engineering in designing products and installing facilities for maximum effectiveness of automation.

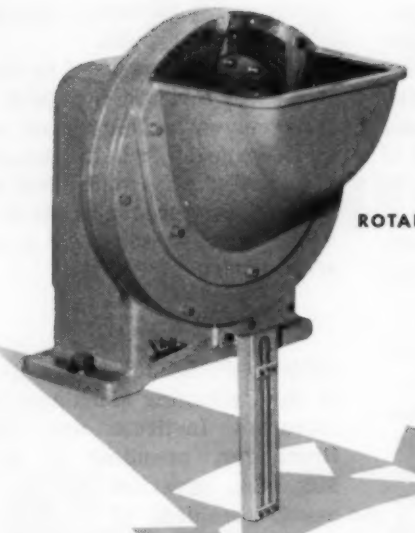
Dialing Made Easy

AUTOMATIC dialing of telephone numbers is possible with the Dialaphone, designed and manufactured by the James Kilburg Corp., San Mateo, Calif. The dialing device is used alongside, and is about the



INTEGRATED automatic test and inspection system for the evaluation of a wide variety of electronic components and other products has been announced by Electronic Control Systems Inc., an affiliate of Stromberg-Carlson, a division of General Dynamics Corp. The equipment automatically transports, tests and physically sorts for quality, components such as semiconductor diodes, etc. and in addition, keeps pertinent records on punched paper tape and assembles overall quality statistics. System consists of five basic elements: automatic hopper feed mechanism, automatic sorter, automatic tester and recorder, automatic analyzer, and a keyboard input to the automatic analyzer.

ROTARY HOPPERS



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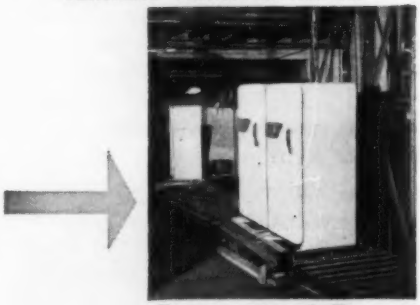
Send sample parts and production details for engineering recommendations.

SPEED UP
"Between-Floors"
CONVEYOR LINES

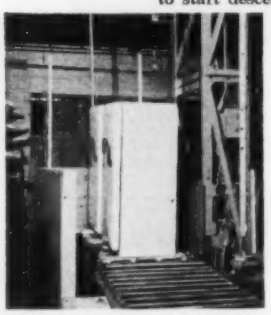
Weld-Bilt
Automatic
"VERTICAL
TRANSPORTATION"

Weld-Bilt Floor-to-Floor Elevators are designed to improve your conveyorizing between two or three floor levels. Highly versatile in application, they provide completely automatic loading, unloading, lifting or lowering — with limit controls, brakes, inclinable or mechanical platforms, selector push buttons in any combination to suit your product and conveyor systems.

TYPICAL WELD-BILT
"VERTICAL TRANSPORTATION"



Freezers automatically conveyed to elevator on top floor. Freezer weight trips controls to start descent.



Roller platform automatically tilts at lower level to discharge freezers to conveyor. Load release starts elevator ascent to top floor.

If your production flow can benefit by floor-to-floor conveyorizing, write for suggestions on Weld-Bilt "Vertical Transportation."

Weld-Bilt Automatic Conveyor-Lifts Elevators, Portable Elevators, Drum Elevators, Lift Trucks, Pallet Trucks, Hydraulic Lift Tables, Skid Platforms, Special Equipment.

WEST BEND EQUIPMENT CORP.
MATERIALS HANDLING ENGINEERS
347 WEST WATER STREET • WEST BEND, WIS.

Circle 562 on Inquiry Card

size of a standard handset telephone.

The apparatus is designed to save the user the trouble of dialing frequently called telephone numbers. Names and telephone numbers up to a capacity of 850 can be placed on a coded tape-like directory operated by a small hand crank. A name and number is quickly located by means of an alphabetical finder. To make a call, the tape is turned to place the desired name in a viewing frame and as soon as a button is pressed, the number is automatically dialed. Names and numbers can be placed on the tape by the user. The directory is expendable and easily replaced, thus providing for complete change of directory in any machine. It is expected that the unit will grow in popularity as direct distance dialing with the necessity of dialing ten or more digits comes into widespread use.

Remote Level Measurements

MEASUREMENTS of the level of goods in storage tanks and bins located up to 4000 ft away from a control point is possible with a recently introduced instrument. Called a capacity telemeter, the development of the Fielden Instrument Div. of Robertshaw-Fulton Controls Co. consists of a measuring unit, a remote probe unit for each tank or bin, and an indicator which can be a meter, recorder or precision instrument.

The unit is connected to the control point through a coaxial cable. It is currently being used mainly by chemical and manufacturing plants, refineries and other industries which store materials in tanks and bins scattered over a sizable area.

NEW OFFICERS and directors of the Packaging Machinery Manufacturers Institute are: **W. B. Bronander,** president of Scandia Mfg. Co., president; **J. H. Richmond,** president of Potdevin Machine Co., first vice president; **E. J. Abendschein,** vice president of Chisholm-Ryder Co., second vice president; **K. B. Hollidge,** executive vice president of Arthur Colton Co., third vice president and chairman of the Packaging Machinery & Materials Exposition Committee.

Polyester Film Forms Unique Conveyor Belt

FOOD PROCESSING FIELD is being served by a new plastic conveyor belt fabricated by joining two sheets of Du Pont's Mylar polyester film with a special white adhesive. The new plastic conveyor belts provide a conveying means that is strong, smooth, flexible, crack-proof, nonabsorbent, immune to attack by oils and greases, and stable under temperature and humidity changes.

The smooth surface of the belt has proved particularly beneficial to the candy industry by imparting a glossy appearance to the bottoms of chocolate covered candy and ice cream products which is similar to the coating on the top and sides.

The belting can be easily installed by the user. The lamination of two 3-mil sheets of plastic is left open for a few inches at both ends. When installed, the belt is fitted exactly to the conveyor and the two dovetailed ends sealed by adhesive. Pressure sensitive tape with a backing of

ROTARY cam-type switch introduced by Clearing Machine Corp. is specially designed for timing of auxiliary functions necessary for automatic press operations. The limit switch is mounted within a dust-tight and oil-free compartment built in to the press frame and is operated directly from the press driveshaft. It is designed to integrate such equipment as stack unloaders, iron hands, die lifters, dopers, etc. with the press cycle.

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starts on page 123

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406	436	466	496	526	556	586	616	646
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417	447	477	507	537	567	597	627	657
418	448	478	508	538	568	598	628	658
419	449	479	509	539	569	599	629	659
420	450	480	510	540	570	600	630	660
421	451	481	511	541	571	601	631	661
422	452	482	512	542	572	602	632	662
423	453	483	513	543	573	603	633	663
424	454	484	514	544	574	604	634	664
425	455	485	515	545	575	605	635	665
426	456	486	516	546	576	606	636	666
427	457	487	517	547	577	607	637	667
428	458	488	518	548	578	608	638	668
429	459	489	519	549	579	609	639	669
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AUTOMATION

Information Service

For your convenience, advertisements and items of information on new equipment, components and manufacturers literature now can be quickly identified by an *Item Number* printed just below each unit.

For additional free information circle item number on an inquiry card. Fill in your name, title, address, etc.—Drop it in the mail—No Postage Required—Your request will receive prompt attention and will be filled directly by the manufacturer.

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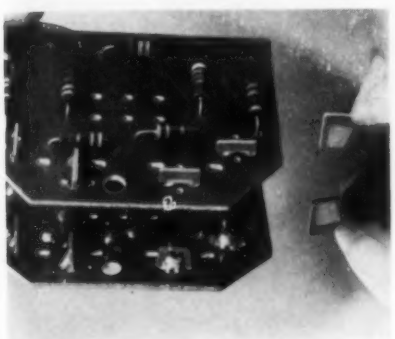
Keep Up-to-Date!

the same plastic completes the smooth finish so important to the food industry.

In addition to food processors, the advantages of the belt are expected to appeal to other industries. Among these are pharmaceutical houses, tobacco operations, rubber products manufacturers, and chemical plants where belting is required with strength and good release properties. For instance, the Gates Engineering Co., Wilmington, Del., is using belting of Mylar polyester film to process sticky calendared rubber stock in its laboratory. The new belting eliminates the need for a release liner formerly used on top of the conveyor belt.



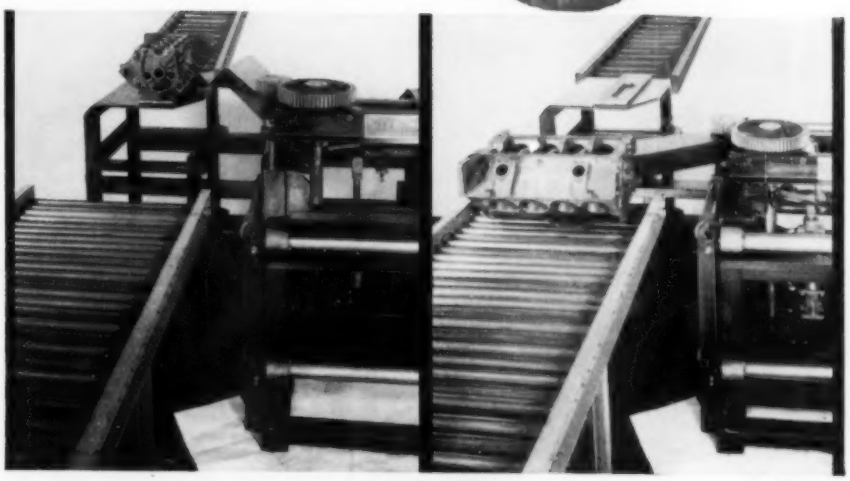
LINE of new, flat tapered ceramic capacitors, designed specifically for use without leads in printed wiring board circuits, has been developed by General Electric's Specialty Electronic Components Dept. The Wejcap capacitors are inserted either manually or by placement machines into slots in the printed wiring boards and are then bonded to the connection point by dip soldering. Mounting the capacitors in a slot does away with the problems of lead placement and breakage, and minimizes problems of lead inductance. The slots to receive the capacitors can easily be punched out with other holes in the board.

Patent Survey Highlights Activity In Electronics Field

FEDERAL government held more than 10 per cent of the 3130 electronics patents issued in 1955 by the U.S. Government Patent Office, according to an analysis by **Lynn J. Bartlett Jr.**, president of Information for Industry.

In the first six months of 1956, 3084 electronic patents were issued, with the pattern following about the same trend as in 1955 except for a slight increase in the percentage assigned the Federal

One...



Two!

HERE'S A

DOUBLE-PLAY*

IN ECONOMICAL AUTOMATION!

Equipment for repositioning engine blocks in an automated sequence is just one example of Buschman creative engineering applied to automatic and semi-automatic production.

Modified and adapted at minimum cost, standard Buschman conveyor components . . . plus Buschman engineering "know-how" . . . solve such problems as automatic loading, unloading, transferring, sorting, dispatching and repositioning workpieces between production operations.

Whether your problem involves automation or dependable every day transportation, investigate the savings possible with Buschman. Remember . . . *when low-cost production is your goal . . . Buschman is your conveyor.* The E. W. Buschman Co., 4544 Clifton Avenue, Cincinnati 32, Ohio.

Write for literature.

* ANOTHER JOB-TAILORED APPLICATION OF **BUSCHMAN** STANDARDIZED CONVEYORS AND ENGINEERED TRANSFER EQUIPMENT

C-329-EWB

WORLD'S MOST COMPLETE LINE OF CONVEYING EQUIPMENT

BUSCHMAN

CONVEYORS

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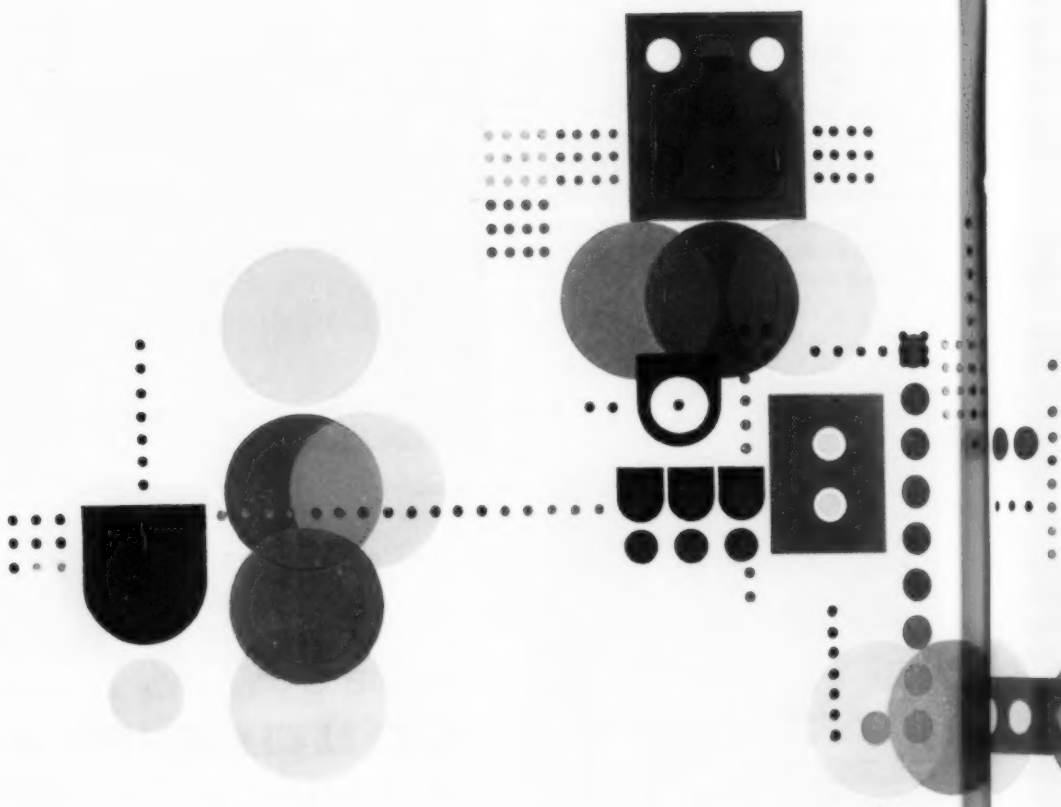
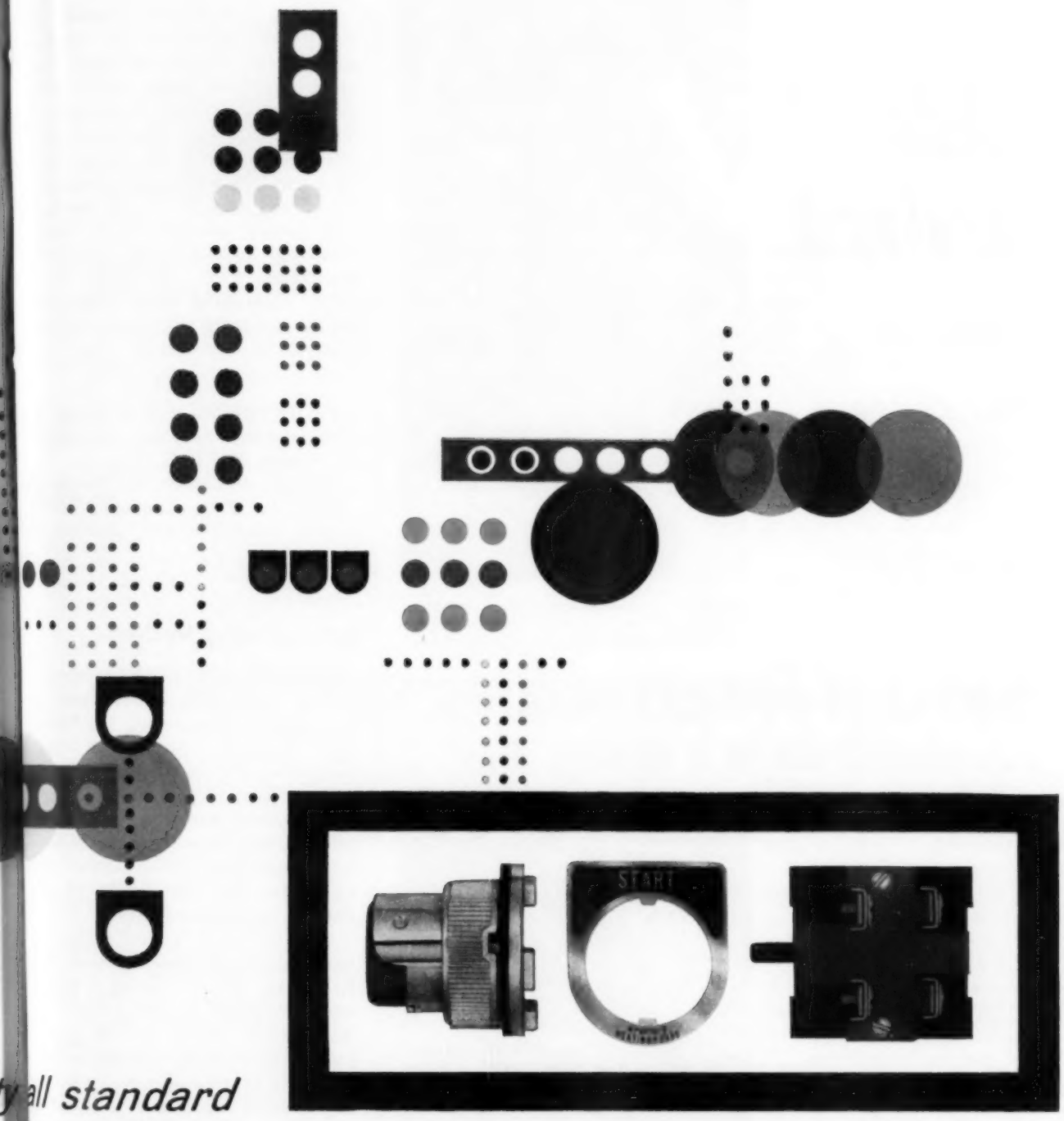


Pushbutton control arrangements almost to infinity all s



...all standard

How'd you like a stock of 1,500,000 pushbutton controls on hand at all times for original equipment needs or for production purposes?
Sound prohibitive space-wise, or too expensive? Not at all. Just 38 Westinghouse components (shown above) do it because all parts are standardized and interchangeable. And always available from stock.
If you need controls for any application, write for the free 72-page *Pushbutton Guide*, B-6749. For control where moisture is a problem, write for free Booklet, B-7022, about Oil-Tite* controls. Write to Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. Or call your Westinghouse Distributor.
*T. M.

J-30248

YOU CAN BE **SURE**... IF IT'S

Westinghouse

Circle 564 on Inquiry Card

Ask Standard

how to

cut costs

with

conveyors

Standard limit-switch-controlled Automatic Reciprocator is one of two used to form 200-ft. overhead detour of dehumidifier assembly line.

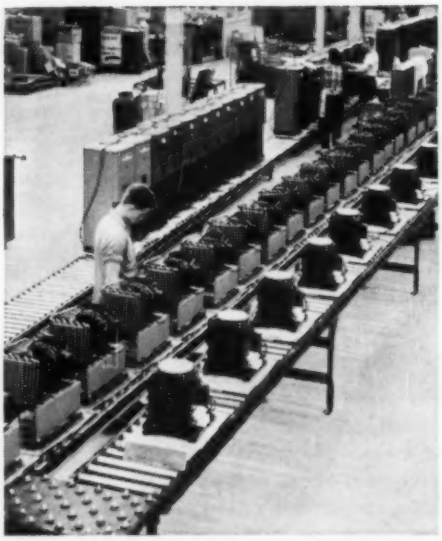
"COMPLETE CONVEYORIZING" . . . what it did in a smaller plant

Products at Ebco stay on conveyors until packaged and sent to shipping.

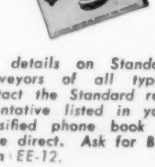
Ebco Manufacturing Company — employing 275 people to produce water coolers, beverage dispensers and dehumidifiers — has realized substantial savings by completely conveyorizing their operations. Ebco engineers planned for an orderly conveyor system when developing plant layout and building design; consequently conveyor system costs were kept "low" and resulting efficiency is "excellent."

Similarly, it will pay you to take another close look at your present conveyor system. Standard specialists will be pleased to help you make evaluations . . . recommend the proper equipment and its application to meet your specific needs.

STANDARD CONVEYOR COMPANY, North St. Paul 9, Minnesota. Sales and Service in Principal Cities.



Gravity roller conveyors like this, used for Ebco's assembly lines, are inexpensive, easy to set up, and economical to maintain.



For details on Standard Conveyors of all types, contact the Standard representative listed in your classified phone book or write direct. Ask for Bulletin EE-12.

government.

By far the largest number of patents were issued to companies whose major endeavor applied to phonograph, radio, television and home appliances. This totaled 674 compared with 264 applicable to telephone, teletype and telegraph equipment, 220 to atomic energy, 151 to aircraft and guided missiles, 92 to petroleum, and 72 to business and office machines. The remainder, some 1657, applied to electronics generally and were not placed by the analysis in any specific field.

APPOINTMENT of **V. L. Percy** as chief engineer has been announced by Seneca Falls Machine Co. The company manufactures Lo-swing and Seneca Falls automatic lathes, special machines and automation equipment.

Grass Growing Machine

DOWN TEXAS WAY a firm is producing automatic grass growing machines. Purpose of the man-made creation is to provide fresh, nourishing forage for livestock the year around. The machine transforms grain into grass 6 to 7½ inches high in six days. Niamco, a Dallas firm, holds American rights for the manufacture of the Belgian development.

The unit itself is a metal framed box with seven drawers or stages. In the top drawer, water is mixed with a special chemical formula. This feeds down to the lower stages. Perforated baskets holding 6 or 7 lb of seed occupy the drawers. During operation the grains and growing shoots are automatically irrigated daily with the solution containing dissolved nutrients. A single, seven-drawer machine can produce forage enough for ten cows. Or, looking at it another way, 50 lb of pregerminated seed can produce daily, 300 to 360 lb of grass.

Temperature control, a critical factor in growing the grass, is achieved through automatic control of electric heating elements. A special control unit developed by Minneapolis - Honeywell Regulator Co. regulates the flow of electricity, thus automatically maintaining

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CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
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DENVER 16—Blair Engineering Co., 4100 Grape St., FLorida 5-7142

ILLINOIS
CHICAGO 43—Mike C. Modrich Co., 10918 South Western Ave., HIltop 5-3640

INDIANA
FORT WAYNE 3—Neff Engineering Co., P.O. Box 2001, Station A, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 20—Neff Engineering Co., P.O. Box 7361, 42nd St. Station, BRoadway 2330
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BAY CITY—Fred Kober, 506 Chilson St., TWinbrook 2-2629
FLINT—Kober Sales Engineering Co., 514 Beach St., CEdar 8-5123
WESTERN MICHIGAN—Everett Adams, 17212 Sharon Road, Chesaning, Michigan, Chesaning 383-J-1

MINNESOTA
MINNEAPOLIS 4—Air Engineering & Supply Co., 2445 Nicollet Ave., FEderal 9-5579
ST. PAUL 14—W. H. Schulz Co., 2438 Franklin Ave., MIdway 4-2791

MISSOURI
ST. LOUIS COUNTY—Oscar E. Jost Co., P. O. Box 6, St. Ann, HArrison 8-4488

NEW JERSEY (Northern)
CRANFORD—The Roden Company, P. O. Box 305, CRanford 6-7330

NEW YORK
BUFFALO 21—C. H. Tepas Co., 200 Washington Hwy., CIrcle 3210

OHIO
CINCINNATI—The R. W. Nichols Co., Fidelity Federal Savings Bldg., 2087-9 Sherman Ave., Norwood, ELmhurst 1-2440
DAYTON—The R. W. Nichols Co., 407 Realty Bldg., MIchigan 4724
OLMSTED FALLS—The R. W. Nichols Co., P. O. Box 6, ADams 5-3366
TOLEDO 4—R. W. Nichols Co., 510 Manhattan Building, CHerry 1-1447

OREGON
PORTLAND—The Rucker Co., 911 N. W. Hoyt St., BEacon 0205

PENNSYLVANIA
PHILADELPHIA—Grand Air-Hydro Co., P.O. Box 141, Glenside, TUrner 7-4296
PITTSBURGH 22—The R. W. Nichols Co., 101 Investment Bldg., ATlantic 1-6050

TEXAS
DALLAS 19—Womack Machine Supply Co., Shea Rd. at 7150 Harry Hines, FLeetwood 7-3871

WASHINGTON
SEATTLE—The Rucker Co., 1000 4th Ave., South, MAin 2783

WISCONSIN
MILWAUKEE 17—Neff Engineering Co., 5856 N. Pt. Washington Rd., EDgewood 2-1579

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN
MAC

precise temperature required.

The machines are not exactly new—to date some 10,000 are in use in Europe, and their use on American farms is expected to grow steadily.

CONSOLIDATION of three firms under a single administrative structure has resulted in the formation of Mandrel Industries Inc. The firms have joined together to place at the disposal of their customers the total resources of their research and manufacturing facilities. The three divisions consist of the Electric Sorting Machine Div., The Greenleaf Mfg. Div., and Electro-Technical Labs Div. Electric Sorting Machine Div., Grand Rapids, Mich., specializes in the manufacture of electronic and pneumatic sorting equipment.

MEETINGS AND EVENTS

Dec. 6-7—

Illinois Institute of Technology. Cost Control Conference to be held IIT Commons Bldg., Chicago. Additional information may be obtained from Illinois Institute of Technology, 35 W. 33rd St., Technology Center, Chicago 16, Ill.

Dec. 10-11—

Material Handling Institute Inc. Annual meeting to be held Biltmore Hotel, New York. Additional information may be obtained from institute headquarters, Suite 759, One Gateway Center, Pittsburgh 22, Pa.

Dec. 10-12—

Eastern Joint Computer Conference. To be held Hotel New Yorker, New York City. Additional information may be obtained from A. Forman, Room 639, 480 Lexington Ave., New York 17, N.Y.

Dec. 19-20—

Radio - Electronics - Television Manufacturers Association. Symposium on Applied Reliability to be held Bovard Hall, University of Southern California, Los Angeles. Additional information may be obtained from RETMA Engineering Office, Room 650, 11 W. 42nd St., New York 36, N.Y.

Jan. 14-16—

Third National Symposium on Reliability and Quality Control in Electronics. To be held Hotel Statler, Washington, D.C. Additional information may be obtained from R. C. Murrell, Melpar Inc., Falls Church, Va.

Jan. 14-18—

Society of Automotive Engineers. Annual meeting and engineering display to be held Sheraton-Cadillac and Statler hotels, Detroit. Additional information may be obtained from society headquarters, 29 W. 39th St., New York 18, N.Y.

Jan. 28-31—

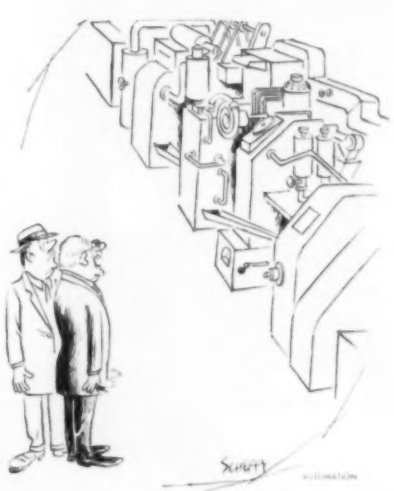
Plant Maintenance and Engineering Show. To be held Public Auditorium, Cleveland. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N.Y.

Feb. 19—

Rochester Society for Quality Control. 13th Annual Quality Control Clinic to be held War Memorial, Rochester, N.Y. Additional information may be obtained from T. J. Soebbing, Eastman Kodak Co., Navy Ordnance Div., 50 Main St. W., Rochester 14, N.Y.

Feb. 26-28—

Western Joint Computer Conference. Jointly sponsored by IRE, AIEE and ACM, conference theme is "Techniques for Reliability." To be held Statler Hotel, Los Angeles. Additional information may be obtained from S. D. Wanlass, 13729 Victory Blvd., Van Nuys, Calif.



"Frankly, I didn't think we'd have to get in so deep just to replace one man."

if you manufacture parts

like these...

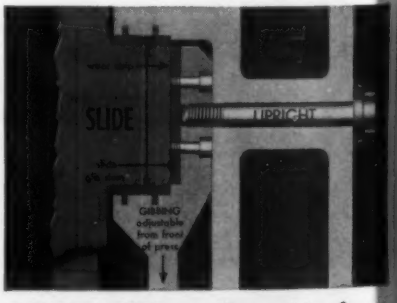
A BLISS HIGH PRODUCTION PRESS

may triple your output...or more

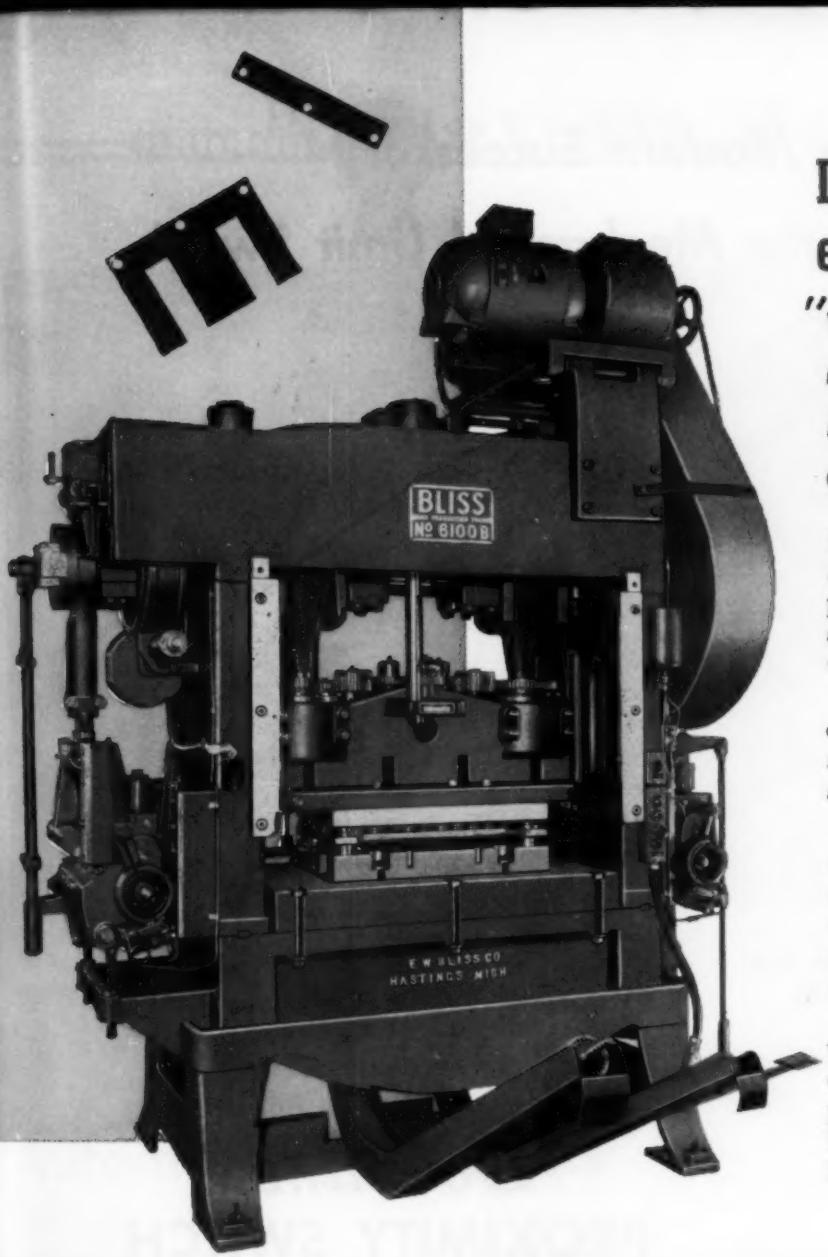
EXCLUSIVE DESIGN FEATURES...assure accuracy at high speed

RUGGED FRAME: The dense, cast Meehanite frame *absorbs sound*, eliminates ringing "ping" at high speeds. Heavy four-piece frame members are keyed and joined by steel tie rods which are "pre-shrunk" to a tension greatly exceeding press capacity. Extra heavy sectioned bed and crown holds deflection to a maximum of 0.001" per foot at press capacity under normal loading conditions. Heavy reinforced crown gives extra support to the shaft. The design of the frame leaves plenty of room for die set up—provides chute space *under* the press.

VARIABLE SPEED DRIVES are standard on H-P presses so that each job can be run at its most efficient speed.



SQUARE GIBS provide precision fit—no more than a 0.0015" feeler goes between gib and slide, although slide moves freely. Location of gibs close to centerline resists tendency of slide to tilt under off-center loads—slide is held parallel to bed within 0.0005" per foot on all dimensions.



Long runs not essential, users report

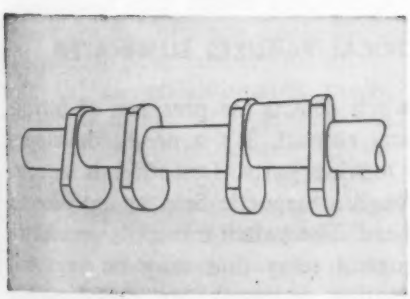
"we set up in 15 minutes, run 3000 parts in another 10..." is typical experience

Consider this: a Bliss H-P Press is usually able to replace from 3 to 12 older and slower presses. And the savings in space, tooling and handling costs alone are often enough to write off the cost of a H-P press.

But the really important saving is in the cost of the parts themselves, because you get so many more so much faster and dies last so much longer.

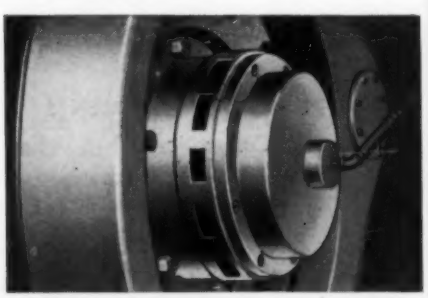
Fast set-up makes that true for both long and short run work. IBM, for example, needs only *eleven* H-P presses to turn out multi-thousand quantities of more than 1500 different parts every three months. Their average set-up time: 48 minutes.

H-P presses are available from 12 to 300 tons, non geared or single geared. Special designs, special feeds extend their use to practically all stamping requirements. We'll be glad to send you complete information by return mail.



COUNTERBALANCED to eliminate vibration. Slide and tools are counterbalanced by means of air cylinder in crown. Where top speed of press requires, the crankshaft is dynamically balanced and the throwblock for the feed is balanced by a compensating weight on the feed adjusting screw.

BLISS FEEDS: Bliss makes its *own* single roll, double roll and special feeds to assure accurate feeding at high speeds. Typical of Bliss design is its roll feed clutch—with *eight* or more rollers bearing on *Stellite* inserts in the hub, it gives greater accuracy *longer*.



AIR FRICTION BRAKE AND CLUTCH: Special design gives die setter and operator complete and accurate control of the press. Air pressure can be set so clutch will slip under severe overloads. In addition, this cool-running clutch automatically adjusts itself for wear.

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Shown ¾ size

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  Has no electrical contacts or moving parts
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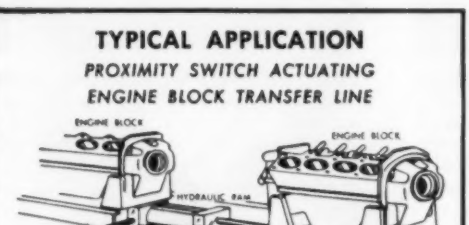
  Uses no vacuum tubes or other components of limited life
- **NO MECHANICAL LINKAGES**
  Requires no physical contact with workpiece
- **FAST RESPONSE**
  Will operate up to 10 times per second
- **POWER REQUIREMENTS**
  Conventional 115 volts 60 cycle source

TYPICAL APPLICATION
PROXIMITY SWITCH ACTUATING ENGINE BLOCK TRANSFER LINE



Doelcam PROXIMITY SWITCH

MECHANICAL AND ELECTRICAL FAILURES ELIMINATED

The Doelcam Proximity Switch detects the presence of ferrous objects without requiring physical contact. It's a newly developed magnetic device containing no moving parts. Detection is accomplished as the object passes through a magnetic field set up directly in front of the switch's sensing head. The switch transmits an electrical signal which operates a control relay that may be remotely located. Many industrial automation processes are replacing the conventional limit switch with the newly developed Doelcam Proximity Switch to avoid work stoppages due to mechanical failure. Among some of these applications are switching operations in materials handling control and automatic machine tools.

Write for Bulletin PS-33.

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Circle 569 on Inquiry Card

By JAMES C. KEEBLER
Associate Editor

Four of the six Danly Transfer Feed Presses recently shipped to the Sterling Plant, of the Ford Motor Co. These presses produce parts for the ball joint suspension units of Ford and Mercury automobiles.

Automated Presswork

FARMERS may expect automated presswork to produce apple cider at the push of a button. The housewife thinks of automated presswork in terms of her "clothes chute to chiffonier drawer" dream of the future home laundry, or equally imaginatively as an automatic way to get rid of the baggy knees on the breadwinner's gray flannel suit.

These things and many others, may come to pass in due course of time as by-products of the present techniques developed by the automakers in automating the presswork on their sheet-metal stampings. Probably one of the reasons that the automobile manufacturers have taken the lead in figuring out ways to get more automatic operations into their press lines is that, from the beginning, a great number of auto parts have been made from sheet metal.

Sheet-metal Rampage

With large quantities of stampings to produce, it was logical that the master mechanics look to automatic operations as a method of reducing costs in this area. Once improved press techniques were devised this advantage was stashed together with the savings incurred by blanking, drawing or forming metal instead of cutting piles of chips, and the designer was encouraged to go on a sheet-metal rampage and call for as many stamped details as his imagination could conjure.

The magnitude to which this production process has grown is best revealed by the fact that the automakers' organizational trends have departed from small press departments within a division or plant to the establishment of stamping divisions that supply various divisions of the corporation. Huge buildings, some in full swing, some under construction—labeled with the words "Stamping Plant"—are housing the latest in press automation on floor space that adds up to be real acreage.

Truly the art of making stampings has become a highly specialized field of metalworking and certainly the auto plants can be chalked up with credit for many of the automation ideas that have advanced the art.

Familiar Outline

Perusal of the status quo reveals that problems of automatic operations in this specialized area fit a familiar outline that has been common to considerations of automation in other fields of production.

One can start with the basic production machine and add attachments to: (1) Handle the material into and out of the dies—this includes the workpiece and any waste material that is produced in the course of making the workpiece, (2) transfer the workpiece from one workstation to the next, (3) perform allied auxiliary functions—such as stock lubricating, (4) interlock the control circuitry of the various segments of the integrated system.

Feeding the work to the dies might be from flat or coiled strip stock or from stacks of blanks. Coiled stock usually passes through leveling rolls to take the set of the coil out of the material before the press hits it. Feeders for blanks must separate one at a time from the stack and place the part into the die.

Waste material may be fed out to a coiler or chopped up by the stroking action of the press and conveyed away from the scene. Pierced-out waste material may be

blown clear of the work area by air jets.

Arm and hand type unloaders are often used to remove the workpiece from the die.

Transfer Fed

Transfer of the workpiece from one station to the next is accomplished in a variety of ways. Where strip stock is used in progressive dies the trick is to leave the parts attached to the waste material strip until you sock it for the last time. This strip is fed through the entire length of the dies and acts as a carrier for the parts.

Where the parts are fed to the press in the form of separate blanks or are blanked from a strip in an early station the parts are moved from station to station by fingers on a transfer bar that connects all stations in a manner similar to that used on in-line transfer machines. Where consecutive operations are in different presses, transfer devices are provided.

Safety First

Having rescued the operator from the jaws of the monster, the problem of wiring the press with interlocked double palmbutton switches (that saved many a limb) becomes instead a problem of interlocking the various pieces of functioning equipment so that the failure of any one of the components doesn't seed disaster elsewhere.

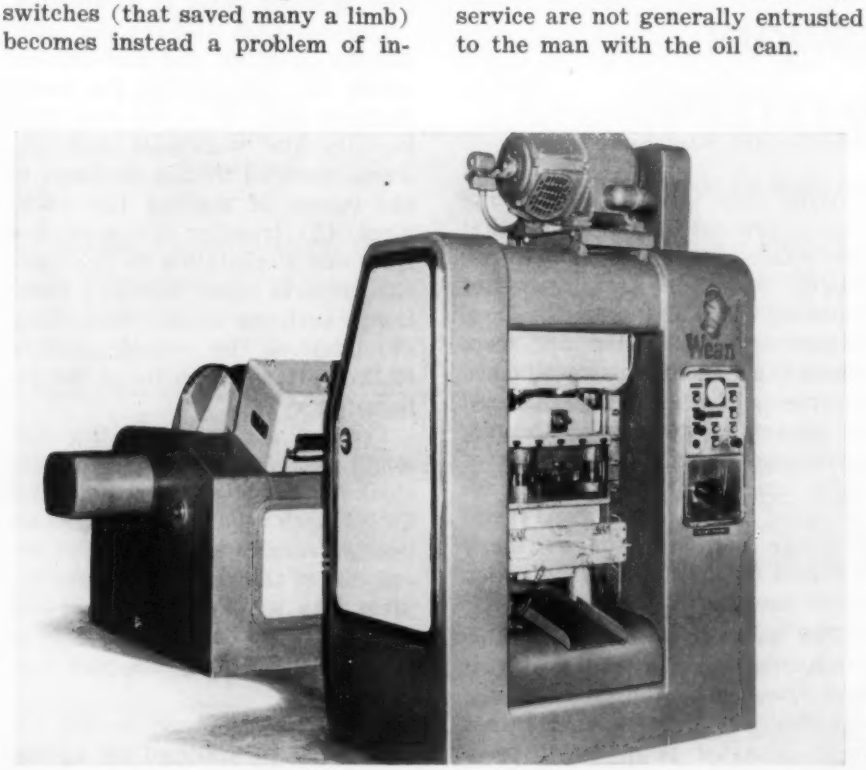
One piece of safety equipment that is required in most auto shops is a safety bar of hefty proportions that is placed between the platens when a setup or maintenance man must get into the danger zone for any reason. This bar is mechanically linked with an electrical connection that disrupts the main circuits and assures that the power is off when the bar is removed from its storage location.

Attached Auxiliaries

Rotary limit switches provide actuation of auxiliary equipment in timed sequence with the required angular position of the press crank.

Manifold-mounted solenoid-operated valves are being employed to provide flexibility and ease of hookup in the control of auxiliary equipment.

Another characteristic of press equipment for use in automated production is the presence of automatic lubricating systems for the journals and slides of the machines. Presses for continuous service are not generally entrusted to the man with the oil can.



Wean Flying Press through which coil stock is fed continuously rather than on a start-stop basis. Designed for high production, press has neither clutch nor brake. Sixty-ton model has blanking speeds up to 450 strokes per minute.

Green with Envy

Many a manufacturing engineer in the automotive game has looked with envy at the continuous production type equipment in use in the packaging industry. The turret type carton filler puts granulated detergent into a continuously moving procession of boxes at the rate of 500 per minute. Not many of the automakers' operations can boast of such a rate.

Press workers are getting a crack at this kind of thinking in the form of the Wean Flying Press. The machine is not airborne, but apparently derives its name from the fact that the strip is continuously on the move and the dies hit the stock on the fly.

Design of the machine is such that pinch-feed rolls are mounted in the rear of the press and are driven through overrunning clutches that allow the die set to pull the material ahead of feeding speed during that part of the cycle in which the die is engaged with the stock.

Upper and lower die halves are mounted on a carrier that continuously moves in a circular orbit. The lower die half is on a slide platen linked to the base of the machine yet sliding in vertical ways on the carrier. During a part of the orbital path of the carrier the die halves come together as they move in the direction that the strip is being fed.

No Stopping

Continuous feeding of strip and continuous motion of the carrier, which operates without the intermittent clutch and brake action of conventional presses, permits operation at high speed. A typical automotive blanking job that ran formerly at 90 per minute is being smacked at 380 per minute.

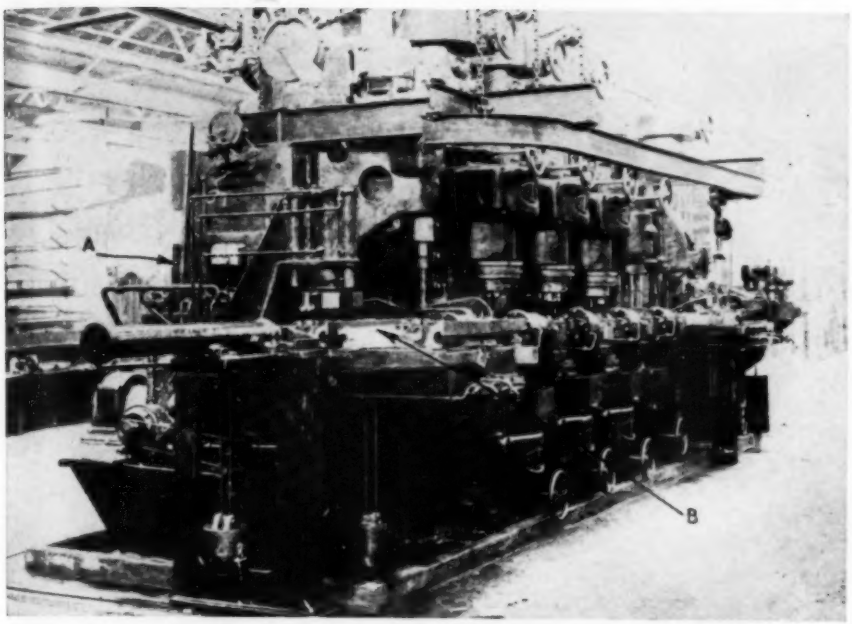
Looks like the geometry of the mechanisms and the problems of flowing metal at high speed would indicate that this equipment is not for deep drawing, but piercing, blanking, notching and shallow drawing operations are slated for some automating.

Pressworking automaters are just like the automation engineers elsewhere: always on the lookout for automatic equipment that will reduce production costs.

Circle 570 on Inquiry Card→

notes from britain

By FRANK G. WOOLLARD
British Correspondent



In this early transfer machine, designed for production of flywheels from steel stampings, parts were delivered at A, where they were loaded into a fixture which was moved to position B for clamping. The workpieces kept perfect register when changing stations in this turning machine.

Twenty Years Too Early

ALTHOUGH the first large hand transfer machine installed by Morris Motors Ltd. had cut cost of machining cylinder blocks by 50 per cent, it had also shown that manually "skidding" the blocks between the 53 stations of the machine was inefficient (see AUTOMATION, Nov. 1956). Full efficiency could only be attained by complete automaticity or, as we should now say, by automation. Hence it was decided that two further large in-line transfer machines and two vertical rotary types should be built. The components that offered the greatest opportunity for in-line machining economies, after the cylinder block, were thought to be the gear box and the flywheel.

The valve guides were considered as the best of the small components on which to test out the rotary types. So orders were placed with B.S.A. Tools, Ltd., for what were, in effect, vertical drum type automatics. It was intended that these should be mounted on frames carried off the stanchions (this was before the days of the open shop) to form closely packed batteries of machines.

In-Line Machines

The flywheel and gearbox machines were, however, true in-line automatic machines. The flywheels were steel stampings which in the rough weighed 57 lb and when finished 43 lb. One face of the flywheel had to be highly finished because it was one of the elements of a two-plate cork clutch. It also had to carry six clutch pins. The machine comprised a number of motor-driven multi-drill and turning heads operated, as to approach and return, by an overhead camshaft driven by a separate control motor. The flywheels were loaded into fixtures which traveled with the workpiece until the insertion of the clutch pins. Thus there was a "train" of seven fixtures, one being an extra to provide for loading and unloading whilst the others were in operation. These fixtures were designed to permit cutting operations from above and below: The cutters revolved in opposite directions to avoid straining the clamping mechanism. The fixtures were moved from station to station and locked in position by pneumatic cylinders.

The operation sequence, which was unusual, was as follows: Rough drill centre hole; rough inside forms of wheel, both sides simultaneously; half finish inside forms; final finish inside forms; drill clutch pin holes from below, reamer and chamfer from above; transfer to idle station, elevate wheel in fixture; hold wheel on magnetic chuck; release and drop fixture onto return track, deliver wheel to next station (wheel goes bare from now on); insert six 2-diameter clutch pins; convey wheel to operating heads, drive clutch pins home by upward plunge of lower head; revolve wheel between upper and lower heads, traverse both rim faces by cam fed tools held in horizontal slides, turn overall diameters; and convey under series of simple heads on back of machine to produce accurate and highly finished surfaces, wheel driven by clutch pins.

Space was left on the side of the machine for cleaning the wheels from oil and chips and for balancing and inspection; so that a completely finished component could be delivered to the assembly line for addition to the engine without the use of further tools. The power bus bars, lighting service, compressed air line, cutting oil pipes and the chip conveyor were all contained in the body of the machine which, be it remembered, was set to work in the early part of 1925. This transfer machine is of particular interest since it was an at-

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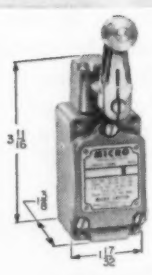
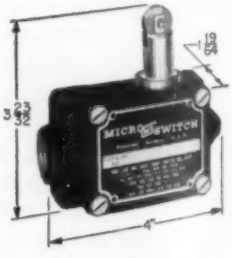
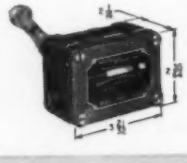


Here is the Type "LS," a small, high capacity two-circuit limit switch. The durable aluminum enclosure protects the switch from physical damage. Seals prevent foreign matter from entering the switching chamber.



High capacity Type "F" enclosed switches are for applications which require a small enclosed switch to handle a large electrical load.



Splash-proof Type "OP" switch assemblies are for locations where splash of liquids would hinder performance of less adequately protected switches.

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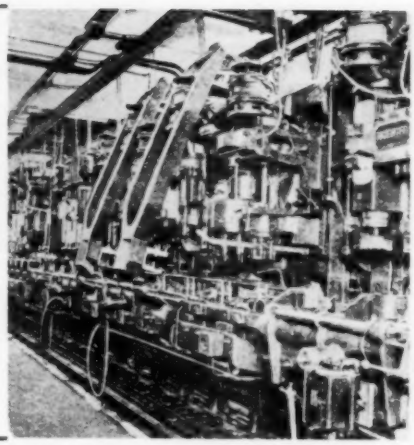

This gearbox machine was the first of the automatic transfer machines. A complete gearbox, including studs and bushings, was delivered every four minutes. The gearboxes were loaded into fixtures and traversed the length of the machine; fixtures were moved between stations and locked in position by pneumatic cylinders. The roller conveyor returned empty fixtures to the starting point.

tempt to produce a turning machine in which the workpiece could change stations without loss of accuracy.

It is not proposed to describe the gearbox machine in any detail since in operation it followed very much the lines of the flywheel machine. This machine again delivered a completely finished unit with all the studs set in the casting. Again there was a long "train" of fixtures into which the gearboxes were loaded at the commencement of operations and which traversed the whole length of the machine to be unloaded at the end. The fixtures were returned by gravity roller track to the starting point while the gearboxes were transferred to the other side of the machine and loaded, manually, into another series of fixtures for further operations. The fixtures throughout this machine were moved and locked in position by pneumatic cylinders. The precise location was achieved by a wedge lock.

Maintenance Was Major Problem

During the early days of these developments we were visited by one of the principals of the Ford Motor Co., who, after spending some hours in examining the machines and the work they produced, gave this verdict: "Well, Woollard I guess you've got something here; but I think you are twenty years too early!" I regret to say that he was a true prophet. The machines when they worked were everything that could be desired, but any slight mishap to the control gear or the electrical equipment involved a long search for trouble which might take an hour, a day, or a fortnight. It must be remembered that the idea of the "package unit" had not been thought of; and when a fault occurred it seemed as though acres of blueprints had to be consulted before the trouble could be found. So, being in the automobile and not in the machine tool business, we reluctantly decided to convert these group machines into single units. It may be noted that we had attempted more than has been since achieved because we produced from the rough casting a fully machined job complete with all fittings such as studs, plugs, etc. This involved heavy milling and boring in addition to the more usual drilling type operations. We were, in fact, endeavoring to carry out an ideal in continuous operation and, but for the want of development in the ancillary mechanisms, we could have succeeded.

It was appreciated that the development of the transfer machine was carried on and brought to perfection (as near as perfection can be achieved in the art of production) by the U.S.A. American engineers were very conscious of the importance of the "package unit" system and in this they were much ahead of their pioneering confreres. Britain, immediately after the Second World War, was too involved in trying to secure her lost markets and too short of capital to embark on new ventures but, in due course, they followed the example of the U.S.A. and now have made further contributions to this fascinating and important aspect of automation. James Archdale & Sons, Ltd., were prominent in the revival and are, today, the leading British firm for in-line transfer machines. William Asquith Ltd. are builders of the larger rotary types of machines.

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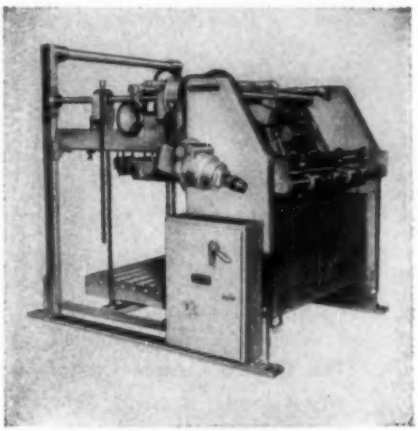
Metal sheets, automatically separated, picked up and advanced one at a time to feeding—in point of machine to which it is attached at speeds up to 150 sheets per minute.

Should two sheets adhere, they are automatically transferred to a reject tray. Rubber suction mouthpieces and drop rollers prevent scratching.

Standard Feeder handles metal sheets from 14" x 18" up to 36" x 44" between 24 and 38 gauge stock. Feeders for larger size and heavier gauge metal sheets also available.



Continuous reloading avoids machine stoppage. New loads are placed in feeding position, while machine is operating, thus maintaining continuous automation cycle.

Dexter Feeder may be attached to Metal Litho Presses, Coating Machines, Sorting Machines, Shears, Slitters, Sprayers, Punch Presses, Stove Pipe Machines, Buffers and numerous other metal working machines.

Custom built sheet feeders for handling paper, cardboard, corrugated and other types of sheets are available to meet specific requirements. Inquiries invited.

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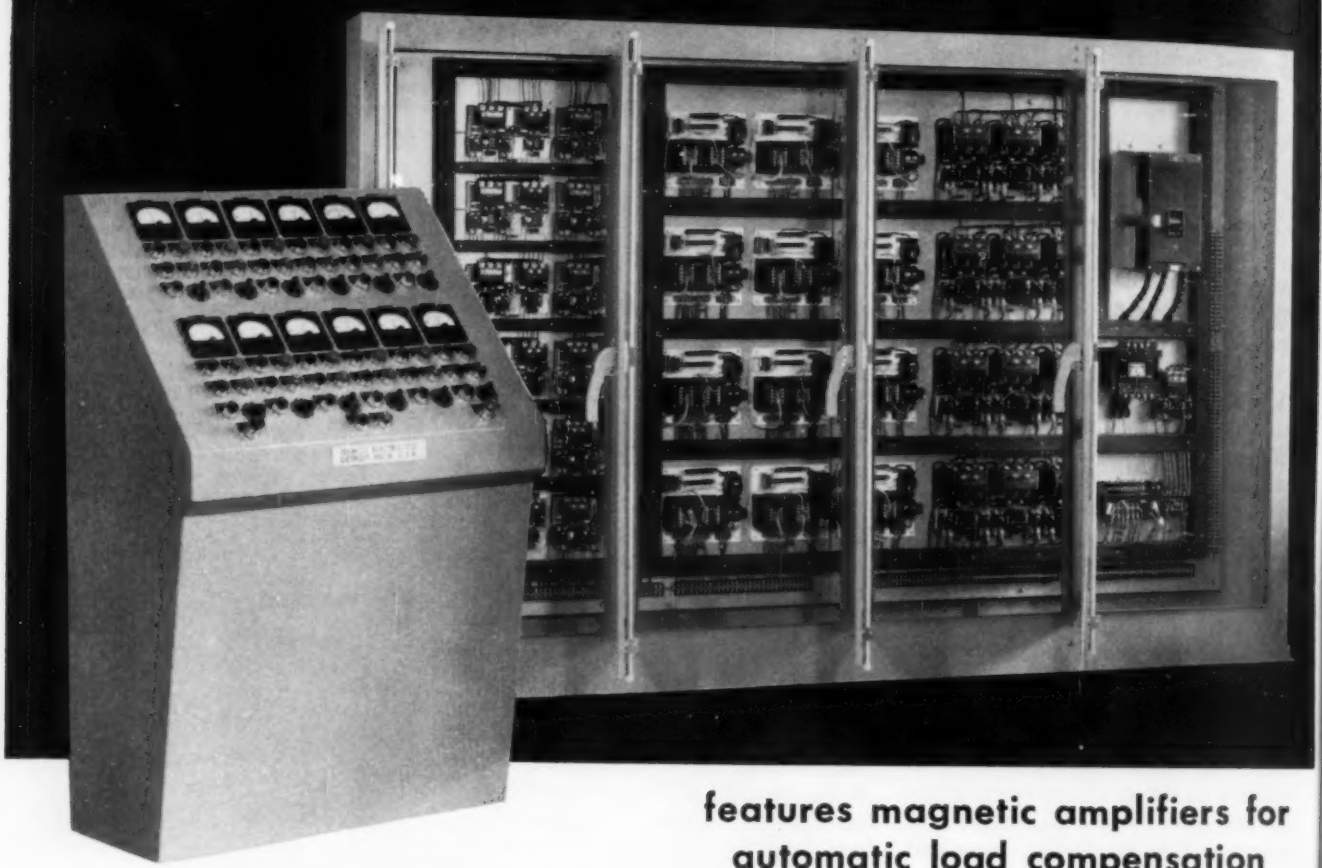
12-SPINDLE polishing stand control



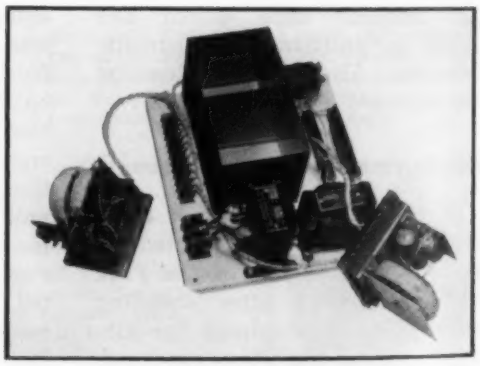
features magnetic amplifiers for automatic load compensation

This Gemco Custom Console enables pre-setting of 12 buffing wheel loads; it saves delays and wasted time by eliminating frequent adjustment to compensate for wheel wear.

On a new set-up, the operator adjusts each spindle load from dials on the console. Indicating meters read spindle currents.

Key to successful operation is the new Gemco-engineered magnetic amplifier, shown dis-assembled at right. It requires no maintenance; *has no tubes* or moving parts; features exceptionally long life. The master panel contains 12 such amplifiers, along with starters for all heads and all spindle feed motors.

An endless conveyor moves parts under each spindle. Once every conveyor cycle, the current load on each spindle is compared with the pre-set optimum on its magnetic amplifier. If the current is too low, the amplifier causes the feed motor to feed in the wheel to increase the load back to optimum.



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A Blind Alley

Modern automation technology is a dynamic new approach to continual improvement in manufacturing economics. New principles and new thinking are involved. But, in many instances management and manufacturing executives are evaluating application of automation by archaic and outmoded methods that are grossly misleading.

Obviously, investment in automation must be justified economically. All too frequently companies choose a simple "rule-of-thumb"—that the investment can be justified on the basis of roughly $5000 for each worker replaced, assuming this as an average yearly pay.

Study of automation solely with this rule-of-thumb will produce disappointing results. Such "horse-and-buggy" direct labor costing methods have little place in today's manufacturing economics and a few facts bear this out. On one hand we find installations involving an investment of approximately $100,000 per man saved, on another this comes to $30,000, and on a third, about $4000.

No basis exists for such a rule. The only useful analysis requires consideration of all important factors—raw material savings, machine utilization improvement, reduced scrap and waste, decreased variations, increased output speed, improved product quality, etc. Cases on record show these factors as the important keys to successful automation. Such yearly savings can more than offset cost of the installation.

Various methods of analysis can be used but they must be realistic. Now, more factual accounting and costing systems may be needed. Based on *known* facts, some rules can then be applied—one company for instance will spend 3½ times the real yearly savings on automated equipment. Depending on the business circumstances, some companies seek to offset the investment in six months, others range up to ten years or more.

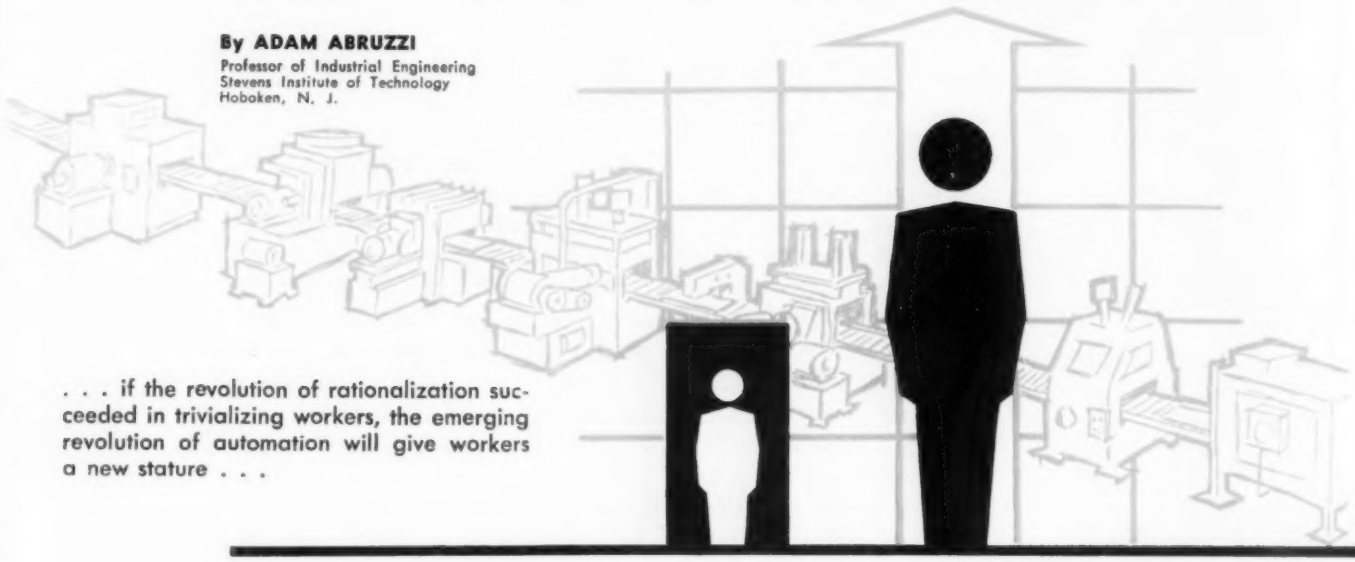
Use of direct labor replacement as a sole means of justifying automated equipment leads up a blind alley. There is no such neat, direct and pat answer to automation economics!

EDITOR

NEW HORIZONS IN LABOR DIGNITY

THE POWER OF AUTOMATION

By ADAM ABRUZZI
Professor of Industrial Engineering
Stevens Institute of Technology
Hoboken, N. J.



. . . if the revolution of rationalization succeeded in trivializing workers, the emerging revolution of automation will give workers a new stature . . .

THIS ARTICLE really grew out of personal feelings, if the reader will pardon such a nontechnical expression. This is a time in which not to be rational is considered a sin, if not sinful. Rational doctrines have arisen everywhere which, in making elbow room for cleanliness, have elbowed aside godliness. To tame the shrew, their ostensible purpose, the rational doctrines seem also to have caged the human spirit. A prison is no less a prison because it is built into the prisoner.

We believe in rational doctrines, it seems, because we rely on our sensory aids instead of our senses. We read words and hear sounds and take them to be the voice and sound of man. But the voice and sound of man is heard more often in muted things, in echoes, and in shadows—things that can be sensed but not measured. So it is with man at his work.

To attempt to summarize the great flood of spoken and written words on the impact of automation is to be valorous without discretion. However, the situation seems to reduce to this: there are two classes of viewers of automation. The first class is made up of untrusting viewers who, at one extreme, may be horrified at the very concept of automation, and at the other extreme, urge penny-pinching caution lest automation burglarize most of our social gains—none won, it should be noted, by using penny-pinching caution. In between the extremes, there are viewers with trepidation, viewers with fear, and viewers of bleak days ahead.

Imaginations, like so many things, resemble pendulums in the way they vary, so the second class of viewers turns out to be a pendulum-image of the first. Here there are trusting viewers who, at one extreme, may see automation as the solution to all ills, and at the other extreme, urge automation forward because automation represents progress and progress represents social gains—none won, it should be noted, simply by trusting in progress. In between, there are viewers with anticipation, viewers with hope, and viewers of bright days ahead.

In words and numbers, the two classes are about evenly matched. But the trusting viewers do have some academic allies, particularly in social science. To many scholars, it seems, alliances of the times, which refer to where one stands, and influences of the times, which refer to where one is, are twin and mortal enemies of theory. With these eased aside, all other things, here and now far from equal, must eventually become equal and social theories, all based on this imagined equality, arise on every side, each promising a Utopia of equilibrium in the long run.

Such theories do have their uses, particularly

in classrooms and colloquia, where speculating on what might be ideal may well give the discerning clues on what is real. But such theories, by themselves, are always oversimplified. Perhaps for this very reason, they are rather fashionable in public forums.

Given the theories, the trusting viewers can suggest, pointing to academic authority, that the problems of automation will generate their own solutions in the long run. Reciting long-run theories in sing-song fashion, the trusting viewers might just as well be saying that because a solution will eventually be had, the process of solution can be ignored. Utopia, it seems, should be seen but not sought.

The trusting viewers also get help, though this is perhaps more subtle, from scholars in science and engineering. These scholars, putting other things equal now rather than later, can prove, sometimes elegantly, that mathematics is capable of yielding a theory of the production process.

This is one of the foremost questions to be considered. A theory is only possible, it turns out, because many production activities have been reduced to bits and pieces. Mathematics can never do more than add and multiply bits and pieces, and we cater to this weakness of mathematics by putting things in that form.

When we delve more deeply into the philosophy of automation, we find a greater contribution than "more things for more people with less effort." We find the possibility of a return to the dignity of human labor; an appreciation of human skills per se rather than degrading of man by measuring his ability against a machine yardstick. We can again be free to work as men.

With all this, what view might we take on automation and society? Perhaps we ought to look at the full sweep of the pendulum and act as though we had stumbled upon a reputedly wealthy but distant relative. We must welcome him with enthusiasm because he might be bountiful but we must be on our guard to see that he doesn't make off with the silver. Expectation is always a blend of valor and discretion and what we can expect depends on how we do the blending. If we expect the silver to become more sparkling, we must be valorous enough to bring it out where it can be seen and also discreet enough to see that it doesn't disappear.

▶ The Revolution of Standardization

The view is widely held that the era of automation represents a revolution of perhaps even greater stature than what currently is called the first industrial revolution. Yet there are those to whom the era of automation is not a revolution at all, and they point, as if in proof, to automatic gadgets of ancient times and ancient places. To argue like this is to argue from the long ago. Here, rather than becoming equal, things always have been equal and, it would appear, a problem cannot be a problem because something that looks the same never was a problem. To argue like this is also to argue from the far away. Now, the atlas replaces the calendar and, since things seem equal elsewhere, things must be equal here. A problem cannot be a problem, it would appear, because no one else seems to have the same problem.

It is true, of course, that no change is ever so sweeping that an analogy cannot be made between things here and now to things there or then. But to rest on such analogies is to suggest that a mountain cannot be steep because there are always some gentle hillocks. If one is willing to see steep mountains, he might well see that, between the early revolution of machines and the new revolution of automation, there has been an intermediate though rather quiet revolution.

In point of time this quiet revolution began at about the turn of the century. In point of concept this revolution introduced reason into industrial operations in the name of rationalization and in the practice of standardization. The explanation for this quiet revolution is obvious and therefore unexciting; industry in its modern form would have been impossible without rationalized operating procedures.

Like most all rational concepts, the concept of rationalization is capable of doing great good. But like most all rational practices, the practice of standardization has been pushed much too far. Since one dose of standardization works, reason the "standardizers," two will therefore work even better, and Utopia will therefore be 100 percent standardized. This has led to a bulging packet of rational doctrines, such as doctrines proclaiming that there is a "one best way" of doing work and doctrines proclaiming that industrial operations can be considered the sum of bits and pieces found here, there, and everywhere.

Standardizers are not fools so they are perfectly well aware that things didn't quite turn out this way. But standardizers are not wise so they reason that if Utopia is not at hand, it must be that Utopia is not understood and, so, Utopia

. . . trivialized work is the step of connecting the bits and pieces into a flow of work . . . such connected flows of work eventually make automation possible . . .

must be explained. As it turns out, Utopia has gotten out of hand, not because it is not understood, but because it is unreal.

▸ Trivialization of Work

To understand the problems of industrial work, one must go back briefly to prerationalization days. Once upon a time most workers made things which were functional entities, perhaps even complete products. Looking back from here and now, it seems tempting to call these workers production craftsmen which, of course, they might well have been in their time and place.

But, with rationalization, many such production activities were dismantled into bits and pieces to be handed here to machines and there to workers. The very ability to do this means that such activities, at least now, are nothing more than the sum of trivial tasks. It is no wonder that it has become something of a fashion to rediscover that, in modern industry, many workers have been made into drudges. This is not a notable discovery: triviality and drudgery may not have the same family name but they are twins by birth.

There is nothing new in drudgery at work. There is something new in the awareness, with rationalization, that much more work can be reduced to trivial tasks. To be sure, both trivialization and drudgery have greatly increased in modern times but this is the payment, the inevitable payment, for the material gains that have come with rationalization.

Trivialized work means drudgery to workers because they can no longer consider their worth in terms of pride in craft, pride in creation, pride in unique accomplishment. Worth can now be specified for them because, with trivial work, the simplest measure of worth is the measure of number. One piece is just like any other piece and, if work must be judged in terms of product, it must be judged in terms of number.

With the worth of work trivialized, it seemed a simple matter to trivialize the worth of workers as well. If product worth could be defined in terms of production units, worker worth should be defined in terms of production units. The standardizers reason that under the unit worth concept, workers will produce more units for more money and, hence, there should be no limit to production if only pay were made proportional to output.

This is the view underlying what are called wage-incentive plans but what actually are output-incentive plans. There are many such plans, all with a common aim: Persuading workers that their worth is measurable in terms of production units, and that the worthy worker is the worker who produces a worthy output. As an aside, the worker who typed the first manuscript draft of this article had it that "the *weary* worker is the worker who produces a worthy output."

To an extent there has been a response to this, and standardizers eagerly display increases in production with output-incentive plans. But the response is always limited because output incentives can be fully persuasive only with creatures who prize nothing but financial gain. But human beings do prize other things, and output-incentive plans must always lead to practices which workers consider protective and standardizers consider restrictive. Standardizers do not seem to see that while production often does go up with output incentives, workers will make sure that production never goes up or down too far.

▸ New Stature of Work

There is an acid test for the doctrines of the standardizers. The test crucible is supplied by the unified production system having built-in regulating and control mechanisms. This is what is or should be meant by automation. It seems a paradox that the era of automation should spring from the era of rationalization. But, as with all paradoxes, there is a hidden but vital step in between.

Although it is not customary for authors to preface articles, there really is no reason why they shouldn't. For one thing a preface can take care of the matter of footnotes which so often are simply an appeal to higher authority intended to impress the reader. I am frankly a borrower, mostly from myself, and for those who might want to look into this, I have taken generously from a paper with a subject similar to this article delivered before the American Association for the Advancement of Science, in Atlanta, Ga., Dec. 1955. This paper, in turn, was based on earlier work: a discussion of labor's strike in *The Challenge of Automation*, Public Affairs Press, 1955, Pgs. 74-77; "Automation and Labor," AUTOMATION, Vol. 2, No. 6 (1955), Pgs. 120-125; *Work, Workers and Work Measurement*, Columbia University Press, forthcoming, especially Chapters 18-19.

The hidden step, given trivialized work, is the step of connecting the bits and pieces into a flow of work. It is such connected flows of work that eventually make automation possible.

The vaunted yet despised assembly line does have the step of connecting and it therefore has all the characteristics of automation except for one thing: It uses human instead of mechanical workers. Comparatively little is made of this man-machine automation, and justifiably so, because, for the most part, the human workers perform routine tasks demanding only slightly more than routine machine skills. Much is made of machine-machine automation, and justifiably so, because the skills of the mechanical workers *are* slightly greater than routine machine skills.

If the revolution of rationalization succeeded in trivializing workers, the emerging revolution of automation will give workers a new stature. Trivial production tasks will be handed over to the machine—proof enough that the tasks are trivial. The industrial society, without the aid of those who keep rediscovering the problem, is solving the problem of drudgery by assigning to the machine the undistinguished skills responsible for drudgery.

A worker will become unproductive to be sure, but only in the sense that he will no longer be evaluated in terms of production units. He will be external to the production activity and he will be its master. This will require distinguished skills of a much higher order than the skills of workers which the machines replace. The status of a human worker will change because he will have given to a mechanical worker the "privilege" of doing trivial work of trivial worth. He will have distinguished status because he will have distinguished skills. Output-incentive plans will vanish in the process; their only possible end is to reduce human beings to the level of machines. Machines are already at the level of machines.

With automation, the standardized component of work, which refers to undistinguished skills, is pulled away from the nonstandardized component of work, which refers to distinguished skills, and is given to mechanical workers. Mechanical workers will have no trouble at all with the restrictions of the workplace, which is a necessity of the standardized component of work. To a mechanical worker, restrictions are simply instructions.

A mechanical worker can and will do these things much better than a human worker. There is no point in dissipating distinguished skills on activities which require only undistinguished skills. Human workers who insist on competing with mechanical workers for the privilege of doing routine chores are pleading, in effect, that they deserve no more standing than a machine.

It is the nonstandardized and distinguished component of work that will be reserved for human beings, and this will be concerned with controlling production activity. Distinguished controlling skills are needed because the internal control apparatus of the mechanical system is incapable of handling problems such as breakdowns. The function of the human overseer-controller — for this is what he actually will be—is to diagnose the situation, locate the seat of difficulty, and take swift, remedial action. He also will have an even more important prognostic function — evaluating operating situations capable of leading to breakdowns. He would then take preventive action to see that the breakdowns do not occur. An effective overseer-controller will thus have idle hands but productive mind, not productive hands and an idle mind.

Control activity cannot be standardized because it requires distinguished skills, the skills of "putting together" which gives dignity to human work. These are the skills whose worth can be measured neither in terms of production nor of time and, this being so, they can never be brought within the reach of a theory. These, indeed, are the skills which reveal human purpose and, in the very revealing, give it stature.

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Mechanical workers will take care of what's left, that is to say, they will follow the doctrines and instructions of the standardizers. There can very well be a "one best way" of exploiting undistinguished skills, just as there can very well be a "one best way" of adding and subtracting the bits and pieces of standardized work found here, there and everywhere. Standardized work must be measured in terms of production and in terms of time and, this being so, it can always be brought within the reach of a theory.

▶ The New Work Morality

It is commonplace to say that industrial revolutions have profound effects on the structure of human affairs. The revolution of machines has been accompanied by fundamental social changes such as those hidden in the word, "urbanization," and fundamental economic changes such as those hidden in the phrase, "laissez-faire capitalism." Many changes in codes of behavior can also be

linked to the revolution of machines though—as always with hard questions—what is cause and what is effect is not completely clear.

The revolution of rationalization was also accompanied by fundamental changes in these same areas, though concededly, they took root primarily within industry. Thus rationalization—not without substantial aid from the revolution of machines—is responsible for the view that toil is virtuous simply because things are being produced, and that idleness is sinful simply because things are not being produced.

Standardizers apparently believe that the devil can find work for idle hands but not for idle minds. In their eyes it is efficient to ignore the human spirit and concentrate on human appendages. The doctrine that there is a one best way of doing industrial work; that unproductive activity must be done away with; that work is made up of constant bits and pieces; that handbooks and slide rules are sufficient for analyzing work—all these and ever so many more in the monotonous repertoire of standardizer doctrines—are nothing more than pebble-size images of the prevailing toil-idleness doctrine.

The revolution of automation will change all this in content if not in form. Idleness will still be sinful, but it will refer to idle minds, not idle hands. Toil will still be virtuous, but it will refer to productive minds, not productive hands.

A new work morality will arise, and it will recognize that accomplishment and worth cannot be defined in terms of a one best way; in terms of keeping one's nose to the grindstone; in terms of bits and pieces; in terms of handbooks and slide rules. The new morality will reward, not only in terms of production units, but in terms of smooth functioning, in terms of planning and organizing, in terms of diagnosis and prognosis.

Like the good family doctor, the good production controller is one who has healthy patients, though not necessarily the greatest number. Like the good family doctor, the good production controller is one who has the leisure at work to pause and to reflect, to use waste time productively and also to waste useful time wisely. Leisure at work will thus mean an opportunity for artful work, just as leisure at living will mean an opportunity for artful living.

To be sure, the new morality will make it possible for hands and minds both to be idle. But this is the price of any morality that has faith in humanity. A morality which holds that idleness must be avoided at all costs must also hold that humanity is not to be trusted. A morality that wishes to hold that human dignity is possible must also make idleness possible. A choice between moralities—as between the technologies with which they always seem to be linked—eventually depends on what is conceived to be the purpose of mankind.

Thus it is that there is no theory capable of measuring the worth of workers, despite pronouncements about the obvious, the efficient, and the virtuous, despite theorems which seek to sum humanity by adding together bits and pieces of this thing or that—all other things, of course, assumed equal. Having an abacus is simply not enough when one seeks to discover what it is that human beings are for.

▸ Prognosis

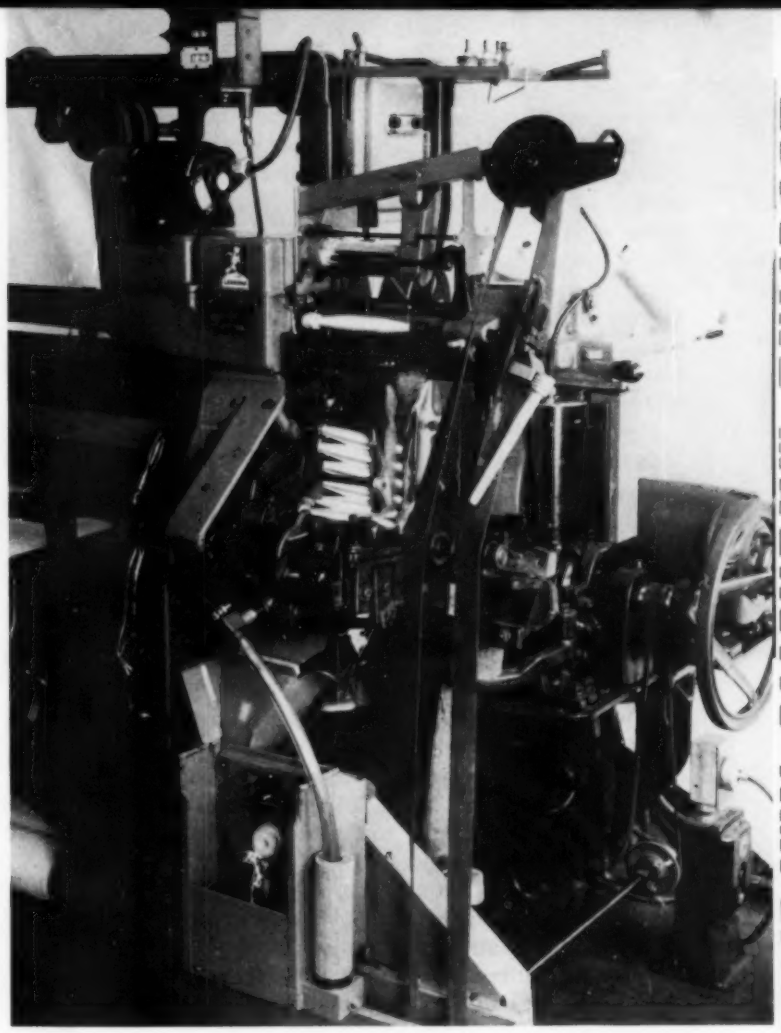
A look at the era of automation as it emerges from the era of rationalization fulfills a number of functions. It has the function of making grounded speculation possible, and grounded speculation is what shapes the future. It is only by thus speculating about tomorrow that today can be appraised; speculating about what might happen in the industrial society puts in sharp focus what is happening in the industrial society. Without such a focus it is difficult to see what is happening because the scene is blurred by standardizer codes patched up to work just a bit longer. Automation makes a clean break with production codes, and it will enforce a clean break with codes of worth as well.

The fact is that a look at automated industry is a look at all industry. This remains true even though no industry will ever fully satisfy the drafting-board idea of full automation, and some industries will satisfy the ideal only in token respects. But all industry will adopt the automation concept of integration, and all industry will participate in the automation process of mechanical production and control.

No industry is immune from the ailments flowing from the fetish of standardization of work, though the pains may not be as great as they are in automated industry. No industry is immune from the need to distinguish between standardized and nonstandardized work activities, though they may not have to be pulled apart in surgical fashion as in automated industry. There is, in the last analysis, no selective immunity from the effects of technological change.

THE AUTHOR

DR. ADAM ABRUZZI at present is in Europe as a result of being awarded a Guggenheim Fellowship for a year's study on the effect of industrial codes and technology on the theory of work. He has been a member of the Stevens faculty since 1950 and through his writings and appearances at seminars and conferences has earned an enviable reputation as an authority on the relationships of labor to automation.



1

Automatic attachment shown on automatic loom integrates filling yarn preparation with weaving operation. Supply packages of yarn are brought directly to loom and placed on one of two holders in the supply creel. Bobbins are automatically wound with yarn, transferred to the shuttle, ejected from the shuttle when nearly empty, and stripped of yarn ends. Empty bobbins are carried from the stripper discharge up to an empty bobbin magazine by the magnetic lifter on the conveyor belt.

AUTOMATION TODAY

INTEGRATION IMPROVES AUTOMATIC TEXTILE OPERATIONS

MANY PLANTS contain examples of operations for which efficient automatic machines have been developed that depend on manual or manually co-ordinated related operations. In some situations these are the most feasible arrangements, but in others they exist because sufficient careful study has not been given to possible integration of operations. An example of a solution to such a problem is found in the textile industry, which is well known for long standing developments in automatic weaving machines. A textile machine builder, Universal Winding Co., with the co-operation of several textile mills, has developed automatic equipment to combine auxiliary operations with the automatic weaving operation to improve cloth quality and reduce production costs.

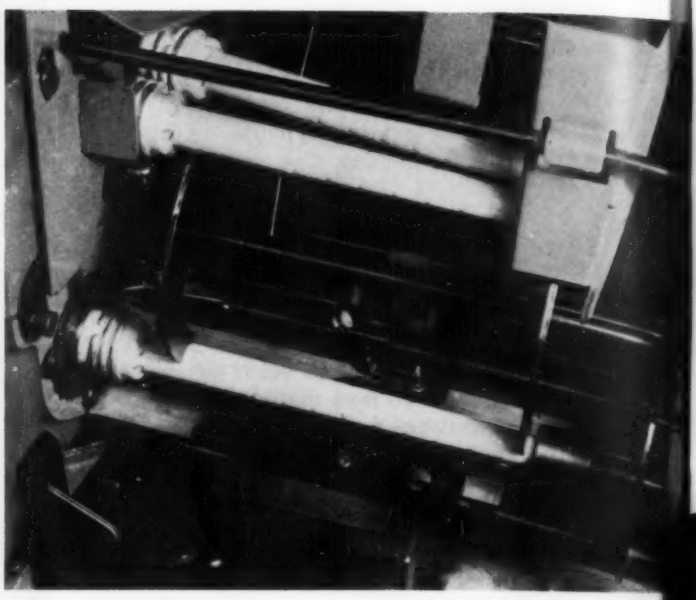
Filling yarn, which is laid back and forth across the weaving machine or loom by a shuttle, is wound on bobbins to supply the shuttle. A wound bobbin is loaded into the shuttle and the filling yarn is woven into the cloth until the bobbin is nearly empty. A feeler mechanism on the loom senses when the yarn on the bobbin reaches a winding concentration or bunch near the yarn end; the shuttle is stopped; and the nearly empty bobbin is ejected and a full bobbin transferred to the shuttle.

Though the ejection and insertion of bobbins has been automatically performed from hand filled

magazines or batteries, the preparation of wound bobbins has been relegated to remote plant areas. The ejected bobbins had to be collected and transported to a stripping area where a stripper machine removed the yarn ends left on the bobbins. Stripped bobbins then were transported to a winding room where they were wound with yarn brought to the winding room in supply packages such as cones, tubes and pirns. Wound bobbins were finally transported to the loom to be manually loaded into the rotary battery.

In the new system, which is illustrated in the accompanying photographs, supply packages of filling yarn are brought directly to the loom and the bobbins are automatically wound, transferred to the shuttle, recovered from the shuttle and stripped by an automatic attachment on the the loom itself. Supply of wound bobbins to the loom is thus directly synchronized with the operation of the loom and becomes as automatic as the weaving operation.

Advantages of this improved textile system are similar to benefits which can be gained by integration of operations in any industry. Quality of product is improved since filling material for any one loom is wound on the same unit under the same tension conditions, and there is no possibility of mixed filling. Elimination of manual handling of the bobbins avoids most of the causes of dirty filling yarn. Plant areas tied up in separate stripping and winding operations are freed for other uses and costs of separate operations and supervision for these operations are eliminated. This points up a further benefit: responsibility for both winding and weaving are centralized and more effective control is possible. Non-productive handling and transportation are eliminated with attendant reductions in wasted manpower, material losses due to handling, and capital and maintenance costs for transportation equipment. Inventory of yarns and bobbins can be reduced and record-keeping simplified.

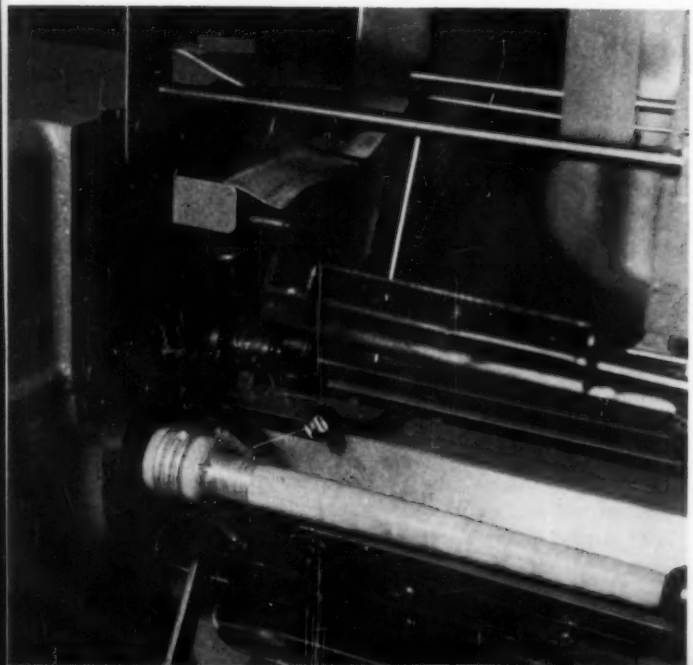


2

Bobbin grip arms move the empty bobbin into winding position and the tailstock (right) moves toward the spindle to engage the bobbin. The grip arms are retracted, the spindle clutch is engaged, and the bobbin begins to revolve. The end of the yarn is picked up by wire cleats on the bobbin and a special winding or bunch is wound on the bobbin so that the loom feeler mechanism can determine the proper time to eject the bobbin from the shuttle.

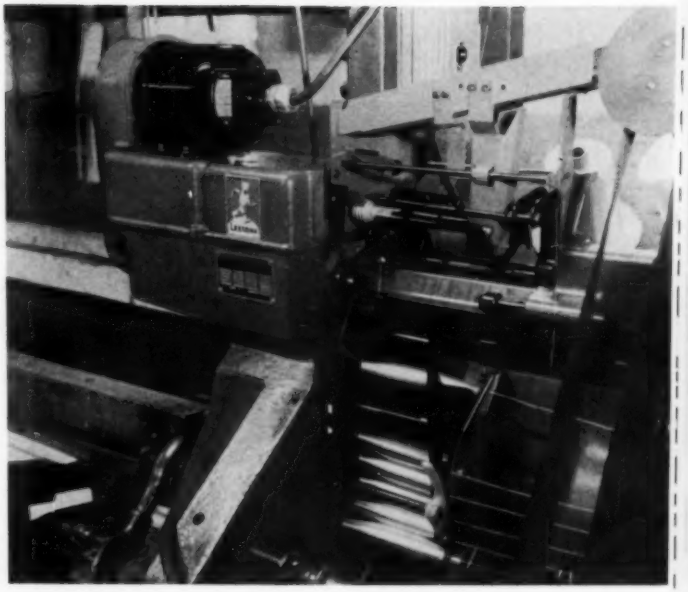
3

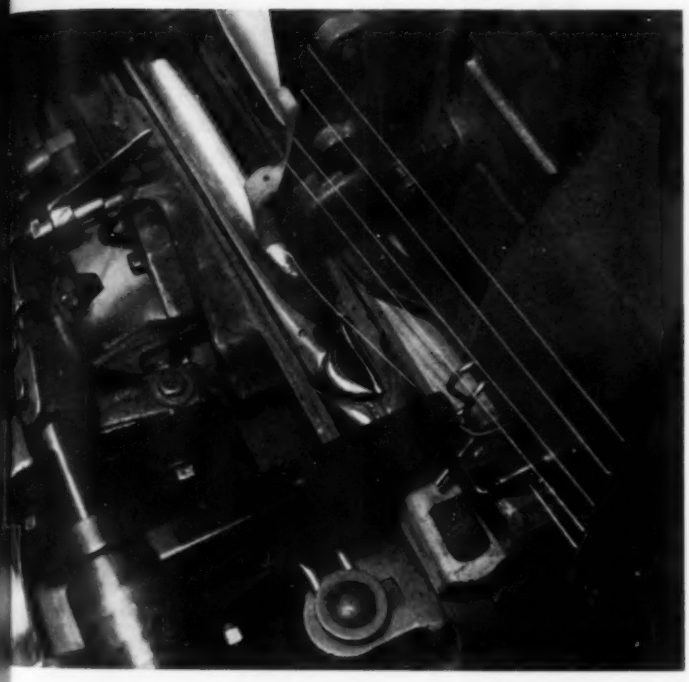
After the preset bunch is built, a collar releases the bunch builder and the rest of the bobbin is wound. When winding is complete a sizing rod is tripped and the bobbin tailstock is cammed out, dropping the bobbin on a rest plate above a full-bobbin magazine; the spindle clutch is released; and the spindle is stopped. The winder then recycles unless an interlock mechanism indicates that the full-bobbin magazine is completely filled. Upper and lower grips advance to clamp, cut and retain the yarn between the full bobbin and the supply creel. The upper grip positions the supply end of the yarn for the cleats of the next empty bobbin and cocks the bunch builder.



4

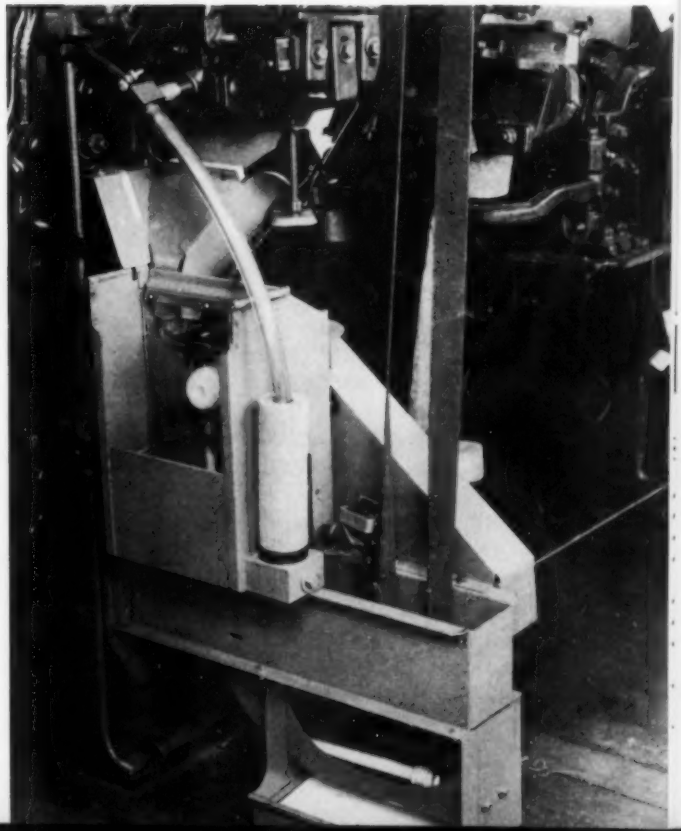
The yarn end from the full bobbin is carried by the lower grip to a tension drum where it is clamped while the grips return to normal positions and the full bobbin drops into the full bobbin magazine. The drum rotates and the end traverses down the drum paralleling progress of the bobbin down through the full bobbin magazine. A butt clamp prevents rotation or movement of bobbins in this magazine except during transfers.





5

When the loom feeler indicates the bobbin in the shuttle is ready for transfer, the shuttle is positioned under the full-bobbin magazine and the transferrer hammer drives the next full bobbin into the shuttle ejecting the empty bobbin. The end of the full bobbin is freed from the tension drum and positioned by clamps near the end cut from the bobbin transferred out of the shuttle. Both ends are then cut by the selvage cutter and deposited in a waste container through an air clearer system.



6

As the bobbin is transferred out of the shuttle a spin is imparted to it by contact with a rubber block in one wall of the shuttle. The spin increases the length of the trailing yarn end. As the bobbin moves down through the stripper the yarn end is picked up by a revolving brush and carried over a revolving stripper cone. Pickup fingers on the cone catch the yarn and cause it to wind onto the cone. Three oscillating cleaning fingers push the yarn off the cone into a waste collector. The bobbin is pushed into a caliper device, and if it still holds yarn it is dropped into a reject tray. If no yarn is detected the bobbin is allowed to fall into the empty bobbin tray where the magnetic bobbin lifter can pick it up for return to the winder.

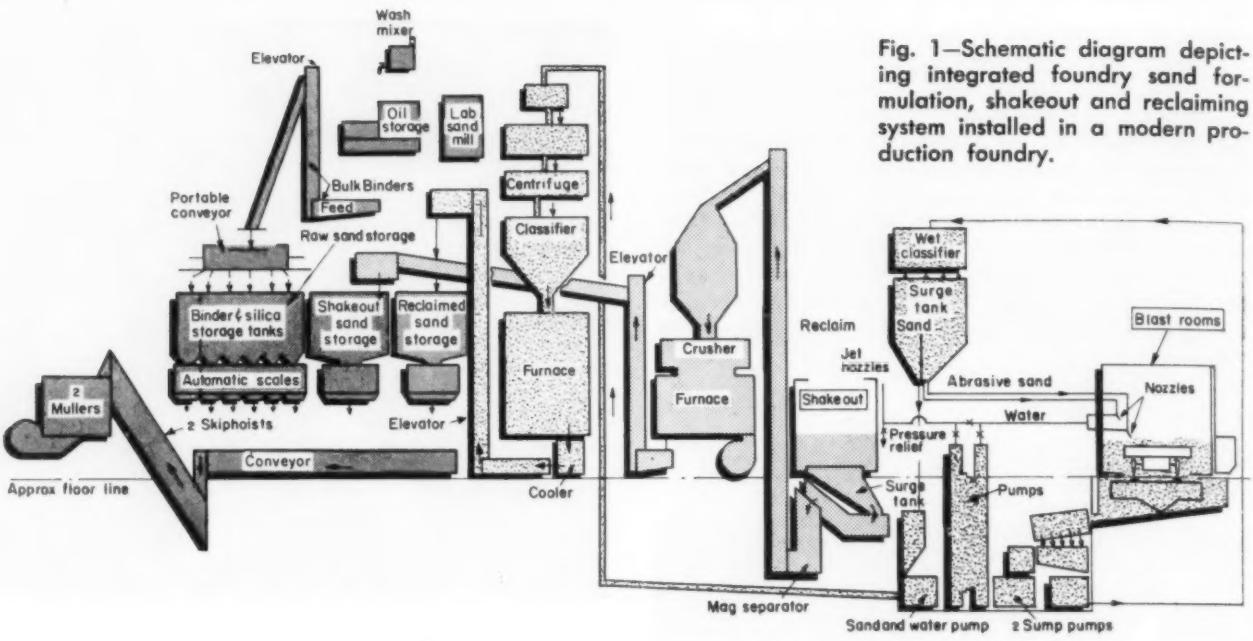


Fig. 1—Schematic diagram depicting integrated foundry sand formulation, shakeout and reclaiming system installed in a modern production foundry.

INTEGRATED FOUNDRY SYSTEM FEATURES

AUTOMATIC BATCH FORMULATING

ONE OF THE REAL OPPORTUNITIES for upgrading castings today lies in improving sand formulations and control. Many foundries are currently giving this matter serious thought. General Electric Co. has set up in their Everett, Mass. foundry what is probably one of the most automated sand formulation, processing, handling and distributing systems in the U. S.,*Fig.* 1. Basic accomplishment in the $200,000 proportioning installation has been the placing of sand formulation under rigid control. G. E. has also been able to boost its production-per-man on sand preparations by 800 per cent.

This foundry makes steel castings weighing from 5 to 36,000 pounds and requires a variety of sand formulations using cereal, bentonite, dry resin, silica flour, washed reclaimed sand, shakeout sand, and new sand. Under its former system of formulating mold and core sands, three mullers were operating steadily: one on a two-shift basis (19 hours per day), and the other two for one-shift. Typical batches averaged less than 1000 pounds each. Two operators loaded and tended each muller and skip hoists feeding the mullers were filled manually with required quantities of sand, binders, silica flour, and wood flour. These ingredients were added by the bag or shovel with measurements being dependent on personal count and marks on the skip hoist. Green sand was made up by feeding ingredients via interlocking conveyors to a central collecting area, the proportions of the mix being controlled by the speed of the conveyors. This sand was stored on the foundry floor.

In its new formulating system, ingredients are automatically weighed out, *Fig.* 2, then conveyed to mullers. Batches are discharged from the mullers and distributed to storage hoppers. The entire handling, processing, and distributing system is controlled by one operator at a central panel board, *Fig.* 3. The batch proportioning system, designed and built by Richardson Scale Co., includes eight automatic scales. In making up a formula, material is collected from the individual scales and fed alternately to two new mullers. These mullers, operating on one shift, can do as much work as the three old mullers formerly did when operating intermittently on two shifts. The new mullers have a 2000-lb capacity, about twice that of the old ones.

Measured quantities of water and core oil are automatically injected into the mix in the mullers, according to the demands of the formula. Practically all used sand is reclaimed. Shakeout now takes place in a three-sided compartment, in which horizontal streams of water help clean the flasks. Sand forced out of the flasks drops through a grid, and is put through a reclamation process. About 20 per cent of the castings are cleaned by high-pressure water blast, and the other 80 per cent are pressure-blasted with a combination of sand and water. Sand is also reclaimed from these cleaning processes.

Ingredient selections are entered on the control board by the operator and the poise weight on each automatic scale is adjusted to deliver the prescribed weight of the selected ingredient. After weights have been selected, the operator chooses the number of batches to be made up. A signal from the control board then starts the batching process. The scales discharge their materials to the collecting conveyor, and progress of the weighing cycle is indicated by colored lights on the control board. The feeding, weighing and discharging cycle is repeated automatically until the required batches have been prepared for that formula.

A swivel spout directs the material to one of two skip hoists which unload into the mullers. The mullers, 2000-lb Beardsley & Piper units, are charged alternately and discharge into a surge tank. If automatic feeding of water or core oil into the mullers should fail, an alarm sounds at the control board.

After they are mulled, the sand mixtures are distributed to storage. Distribution is controlled from the scale room at a panel which controls the operation of the belt-distribution system and the plows located above the various belts. Equipment includes operational indicator lights and a 16-position plow set.

Features of Improved System

Advantages of the improved system include the following:

1. *Increased capacity* — The proportioning system can feed a formulated batch to the mullers every 60 seconds. Foundry requirements for a typical eight hour day are about 150 batches but sometimes this has grown to 200 batches.

2. *Greater flexibility* — Formulas can be changed as often as every five minutes, if desired.

3. *Better quality* — Because of consistent proportioning, effective quality control has become possible.

4. *Cost savings* — As a result of the sand reclamation system only half the amount of sand formerly bought is required. With the new conveying and proportioning system one man accomplishes what would have required nine men to perform under the former system. In addition this operator has time to clean the mullers, reload the binder and sand bins, and run some routine sand tests. With the manual formulating system, mixes contained ingredients that frequently varied from required weight by as much as 20 per cent. Often these weights were on the high side, as operators would tend to add a little extra rather than be underweight, particularly when an essential ingredient was in question. When mixes were so far off that a batch had to be rejected there was an additional waste. The automatic scales feature accuracy of ½ of 1 per cent on all materials weighed.

5. *Easy maintenance* — Over 200,000 batches of mixed sand have been made up since operations began. The only repairs to the batch proportioning system have been minor electrical ones. Maintenance is of a routine variety, and is performed by the scale-room operator and the plant maintenance department. A service man from Richardson checks the scales every six months for performance and accuracy.

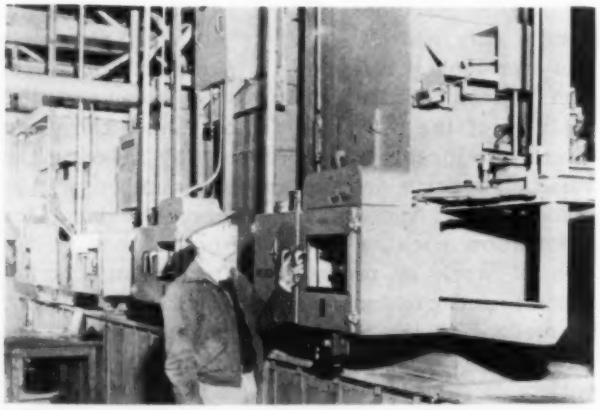


Fig. 2—Four of the eight automatic scales which proportion ingredients for the two mullers used in preparing a variety of mixes. The scales discharge to a collector conveyor.

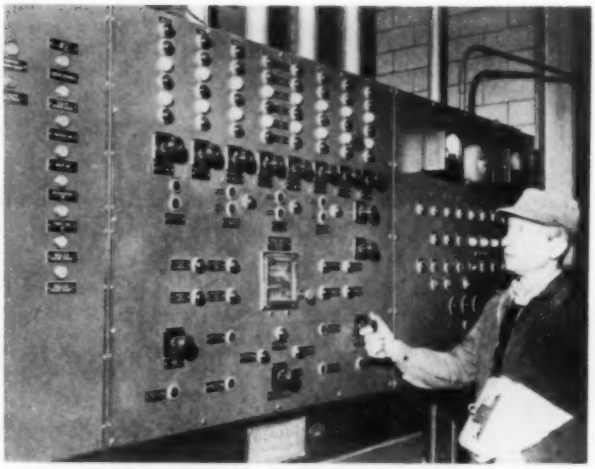


Fig. 3—Entire formulating process is regulated from this control panel. Selector knobs are provided for eight different materials. Lights on the panel indicate progress of weighing and mulling operations.

Interlocks in the proportioning system are designed to make operations as foolproof as possible. Scales cannot start weighing out ingredients for a batch unless there are sufficient quantities in the ingredient bins to fill the batch requirement. The scales will not discharge unless all weighings are in tolerance; the collector conveyor is running; the swivel spout has positioned itself for the selected skip hoist; and that skip hoist is in place. A skip hoist cannot be raised to its muller unless all scales register an "empty balance" indicating complete discharge; all materials have been received by the skip hoist; and water has been injected to the muller. The muller batch will be automatically rejected unless the core oil has been added at the correct time and in the proper amount. A finished batch can be passed for distribution only if every mechanical and electrical function has been exactly as specified; otherwise it will be automatically plowed off the final conveyor and sent to the reject bin.

REDUCE UNNECESSARY VARIETY
TO CAPITALIZE ON AUTOMATION

Unnecessary variety of parts or materials which the automatic factory is forced to produce or process will nullify many of the advantages to be gained through automation. Simplification of design and manufacture is the keynote, but how can we determine what is unnecessary variety and what is essential difference?

By R. S. GEOGHEGAN
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E. G. Brisch & Partners Ltd.
London, England

OF THE PRODUCTION and manufacturing techniques which have been extended since the war, simplification, standardization and specialization have probably received less attention than any other management study, considering the great potentialities which they possess in reducing manufacturing costs. Reluctance to implement new methods is often due to lack of a clear understanding of their true meaning and definition, and to the absence of a satisfactory and proved method of approach and application.

To keep the meanings of the three S's in their simplest form, the following are acceptable definitions:

Simplification—the process of reducing the number of types and varieties made.

Standardization—the process of securing the maximum utilization of preferred varieties necessitating agreement on standards of performance, quality, composition or dimensions and the application of that standard.

Specialization—the devotion of particular productive resources and processes exclusively to the manufacture of a narrow range of products.

There is a very close relationship between two of these, namely, simplification and standardization, since the very process of reducing variety naturally results in greater utilization of the remaining variety.

The time which elapses between the placing of a material or part into process and the time when that part is finished-machined or the product assembled ready for shipment is made up of two periods—that during which work is being done on the material or part to change the shape, form, finish or appearance; and that during which no such work is being performed and the item is either waiting for the next operation, or is in the process of being moved from machine to machine. The former is often referred to as productive time and the latter as nonproductive time. Specialization through the use of special purpose machines and tools, designed specifically for each machining or assembly operation, aims at reducing the manufacturing cost by cutting productive time.

Automation has the added advantage of handling materials and parts into and out of machines and aims at reducing nonproductive time by simplifying the handling of materials and parts between operations, and minimizing the idle time spent on the shop floor. Automation, therefore, is a counterpart of specialization and its effectiveness will be strongly influenced by the variety of component parts to be machined or of materials to be used, since the smallest difference means a new item has to be introduced and, therefore, causes disturbance to the ideal cycle of automation.

Automation, whether expressed in the form of an electronically controlled plant or in the form of transfer machines, will yield the most economic results only when the variety of parts, materials and even tools is reduced to a minimum. Simplification and standardization, are, therefore, essential features of the automatic factory, since they lead directly to longer production runs by reducing the variety of parts designs and the number of machine setups. The many advantages claimed for automation, such as saving of direct labor, reduction of work in progress, better manufacturing control, and greater machine utilization, will not be realized to the full unless products are so designed as to be constructed out of the minimum variety of component parts, and unless these component parts are in turn made from the minimum variety of materials.

There are clearly, from the point of view of the user, varieties of these items which are essential

WHAT'S IN A NAME?

Pin	Latch	Roller spindle
Pin hinge	Button	Lever spindle
Peg	Stud	Armature stud
Locating Peg	Rod	Pinion spindle
Dowel	Hinge Rod	Slave spindle
Brush	Lock Rod	Clutch roller
Valve cotter	Push Rod	Counter shaft
Canopy rod	Valve rod	Reset spindle
Roller shaft	Plain rod	Straight pin
Pivot	Rivet	Armature stem
Brush	Spacer	Contact spindle
Plug	Post	Drain tap boss
Spindle	Bar	Piston rod pin
Stop	Dashpot rod	Handle stop pin
Roller	Valve Stem	Pin push lever
Plunger	Flag pivot	Fuel pump tappet
Connector	Crank rivet	Kicker catch pin
Trunnion	Roller pin	Thrust collar pin
Electrode	Pin link	Carrier link pin
Pin pivot	Post mileage	Sanding valve
Pin anchor	Location pin	Valve cotter pin
Pink crank	Operating pin	Clutch toggle pin
Drive pin	Trip arm pin	Swing bolt pin
Pivot top	Pawl spindle	Pin-towing eye
Plain pin	Special pin	Wheel stud dowel
Dowel pin	Eyebolt pin	Water pump dowel
Wire pin	Bearing pin	Chain Anchor dowel
Bond pin	Dividing bar	Jack leg plug

Sealing sleeve driving pin	Dowel for main bearing
Intercooler fitter dowel	Reset frame shop pin
Starting handle shaft pin	Breather hole plug
Distributor drive plain pin	Selector bar plug
Water pump driving pin	Governor weight spindle
Governor drive coupling pin	Connecting link rod
Manhandling bar knuckle jaw pin	Oil relief ball stop
Water pump spring collar peg	Float lever stud
Pump drive centre driving peg	Contact lever axle
Inlet rocker bracket oilway plug	Pin clamp plate
Armature cradle bearing rod	Pin mould holding
Connector moving oscillator coil	Motor Drive spindle
Main spindle location pin	Sanding valve roller
Armature laminated rivet	

Fig. 1—The 111 names in this list are actual names found among the drawings of four different manufacturers and describe plain single diameter pins.

and those which are nonessential, and it is necessary, at this stage, to distinguish between the two. The essential variety is that which is important from a sales and customers' point of view—such features as pattern, color, styling, performance, function and shape are typical examples. In a broad sense, they may be described as the visible variety. For example, none of us would wish to wear clothes which are so limited in design, style and color that our choice is restricted. The choice of a new car—within the price range suitable to one's pocket—is not determined by the steel alloys used in the steering column or structure of the brake mechanism, but by those features which satisfy the personal requirements of the purchaser, such as color, comfort, simplicity to drive, economic fuel consumption and easy maintenance. A wide visible variety of the finished product is vital for effective sales promotion and development, and if it meets the customer's requirements and gives him full satisfaction, he is not interested in the internal invisible features which constitute the controls or working parts.

▶ Causes of Unnecessary Variety

Primary cause of unnecessary variety is the absence of precise identification and the lack of simple facilities to locate past designs. Ambiguous descriptions, fortuitous nomenclature and meaningless numbering give rise to confusion, waste and unnecessary inventory. Similar and even identical items, designed for different assemblies and products, become concealed and often impossible to trace because of the widely different descriptions

CHANGES IN "NAME" ALTER THE DESIGNATION

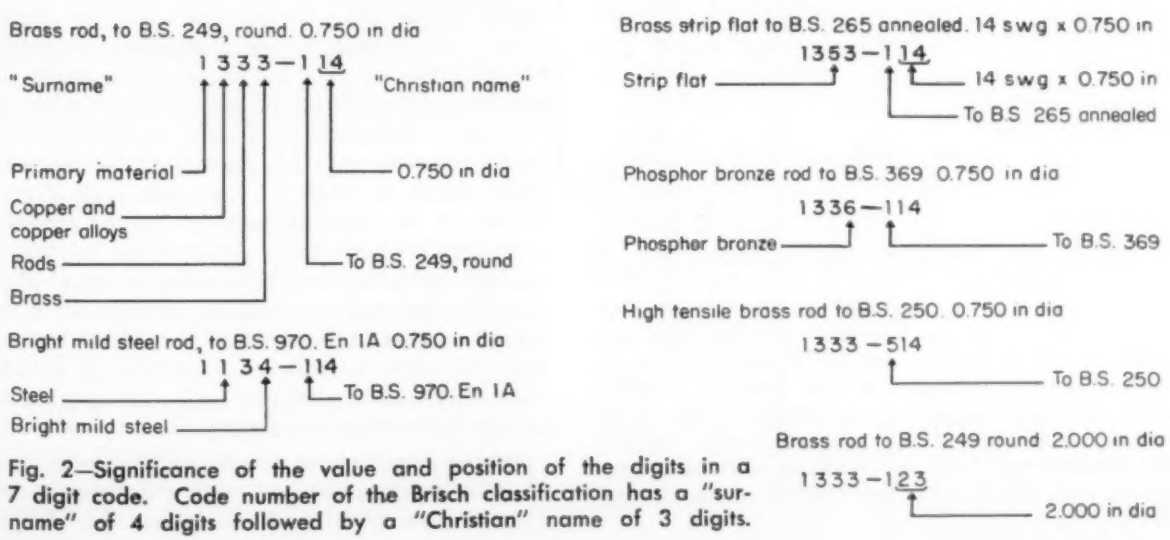


Fig. 2—Significance of the value and position of the digits in a 7 digit code. Code number of the Brisch classification has a "surname" of 4 digits followed by a "Christian" name of 3 digits.

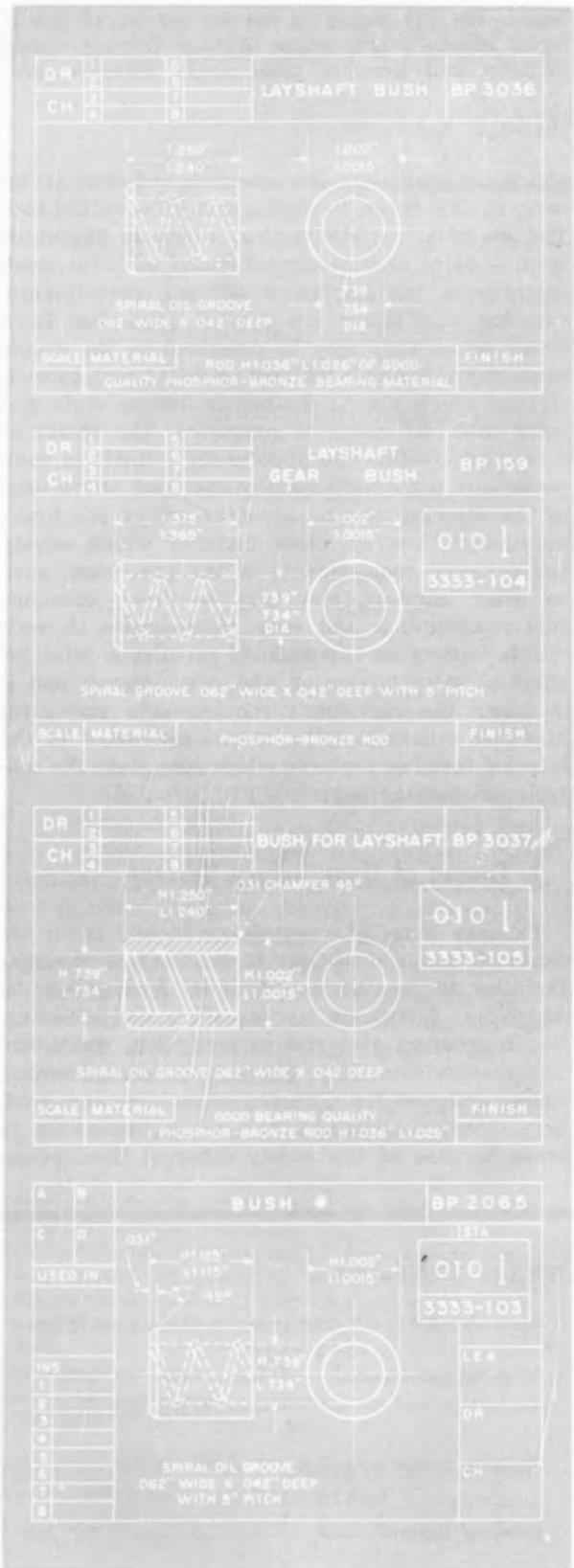


Fig. 3—Illustrating unnecessary variations, these four "bushes" differ only by ¼ inch in length. One was required ⅛ inch shorter than BP159, the drawing of which had been located. A new drawing, BP3036, was made and existing parts to BP159, known to be in stock, were cut to produce the new length. BP3037 was identical with the one required and newly designed, and was at a higher level of inventory than BP159.

which they acquire at the design stage, *Fig.* 1. Often new tools are made and unnecessary operations performed when parts are designed and materials are used for which closely similar and even identical ones already exist.

The first essential step toward correcting these situations is the precise and unambiguous identification of the items under consideration. This is the only means whereby the true nature of the variety, and its extent, can be established. The next step is to classify all items whether they be materials, purchased commodities, components or tools, in such a way that like items within each category are brought together according to their common features and subdivided according to their essential differences, *Fig.* 2. Only by precise identification and systematic classification is it possible to reveal the existence of duplications or unnecessary similarities, or to reveal past drawings of suitable components and tools which can be used, modified if necessary, instead of designing new ones. Lack of such facilities results in the creating and accumulation of unnecessary stocks which soon become idle, slow moving and even redundant, and, in consequence, wastes much design time, creates problems of storage space and stock maintenance, means extra work for the purchasing department and unnecessary trouble in placing orders, causes new tooling to be made and results in shorter runs in the production shops, *Fig.* 3.

The classification and coding method evolved and developed over a number of years by E. G. Brisch, *Fig.* 4, is based upon clearly defined principles to provide management with a tool for simplification, i.e., the elimination of unnecessary variety. Foremost is the need to select characteristics from the point of view of the user. For example, from the point of view of the maker, the steel bar is his finished product, but to the motor car manufacturer using this steel bar, it is a primary material. Characteristics selected should be determined irrespective of use, performance or location. In the case of material, they would be determined by the nature of the material, whereas for a component it would be the basic design characteristics which would be selected, and not the arbitrary title or description of the component. To establish a technique of this nature and to enable comparisons, particularly of similarities, to be made readily, a numerical code must be designed which will symbolize all the classified descriptions of these items in such a way that each digit, by virtue of its position and its value, signifies a pertinent characteristic. As a result of this specialized and systematic approach, all levels of management are able to find an existing item or to ascertain that a particular item does not exist, find all items capable of satisfying a given requirement, and determine all the requirements which a given item can satisfy.

Brisch classification takes the form of a catalog of item descriptions and code numbers, in which there is one place and one place only for each

item. Terms like miscellaneous, sundry, and etc. are never used. The construction of such a classification necessitates a clear appreciation of the user's requirements, since it is essential that the classification be tailor-made to suit the specific needs of each particular organization. Also required is a sound technical knowledge of the technique so that adequate room is left in the classification framework for expansion, avoiding any possibility of breakdown.

Only if designed around these principles and with these objectives in view, will classification and coding bring to light whether the retention of certain items is justified, *Fig.* 5; whether there are duplications; whether materials are redundant; whether a component about to be designed does in fact already exist; whether, if no existing component is suitable, a closely similar one can be used; and whether existing tools can be used, or obsolete ones resuscitated.

While this technique of identification and classification results in a process of automatic simplification by revealing the close similarities and duplications, further reductions of variety are obtained by the deliberate elimination of unnecessary types and sizes—a process of deliberate simplification.

In the case of materials and commercially available purchased items, schedules of preferred and nonpreferred ranges of types and sizes must be established. Preferred items are those which are in common use and normal supply, and which the designers are encouraged to use without the need for authoritative approval in preference to other items in the same category. At the same time no restriction should be placed upon the designer against introducing new items, if these can be justified in the interests of technical progress, improved machinability or cost reduction. The nonpreferred items—those which are superfluous because of redundancies, accepted equivalents or alternatives—can be eliminated. Disposal can be effected by using these items in production or maintenance, reprocessing or exchanging with the supplier for preferred types and sizes, or selling for cash or credit to the best advantage.

Accumulation of numerous entries under the same heading is often a pointer to needless variety. It must, however, be emphasized that the work of simplification requires an analytical approach. From a warehousing point of view, stores having a low rate of turnover are generally the ones which can most easily be dispensed with. On the other hand, those extensively used are not always the ones to be retained. The extent to which a firm's spare parts and maintenance services constitute a large proportion of their business may strongly influence the need to rationalize design, reduce existing variety and control future variety. Excessive variety will complicate and perhaps make insoluble the problem facing management in developing and applying factory automation.

Comparatively little thought has been given to the very important expenditure of inventory costs. Many firms are of the opinion that it costs them

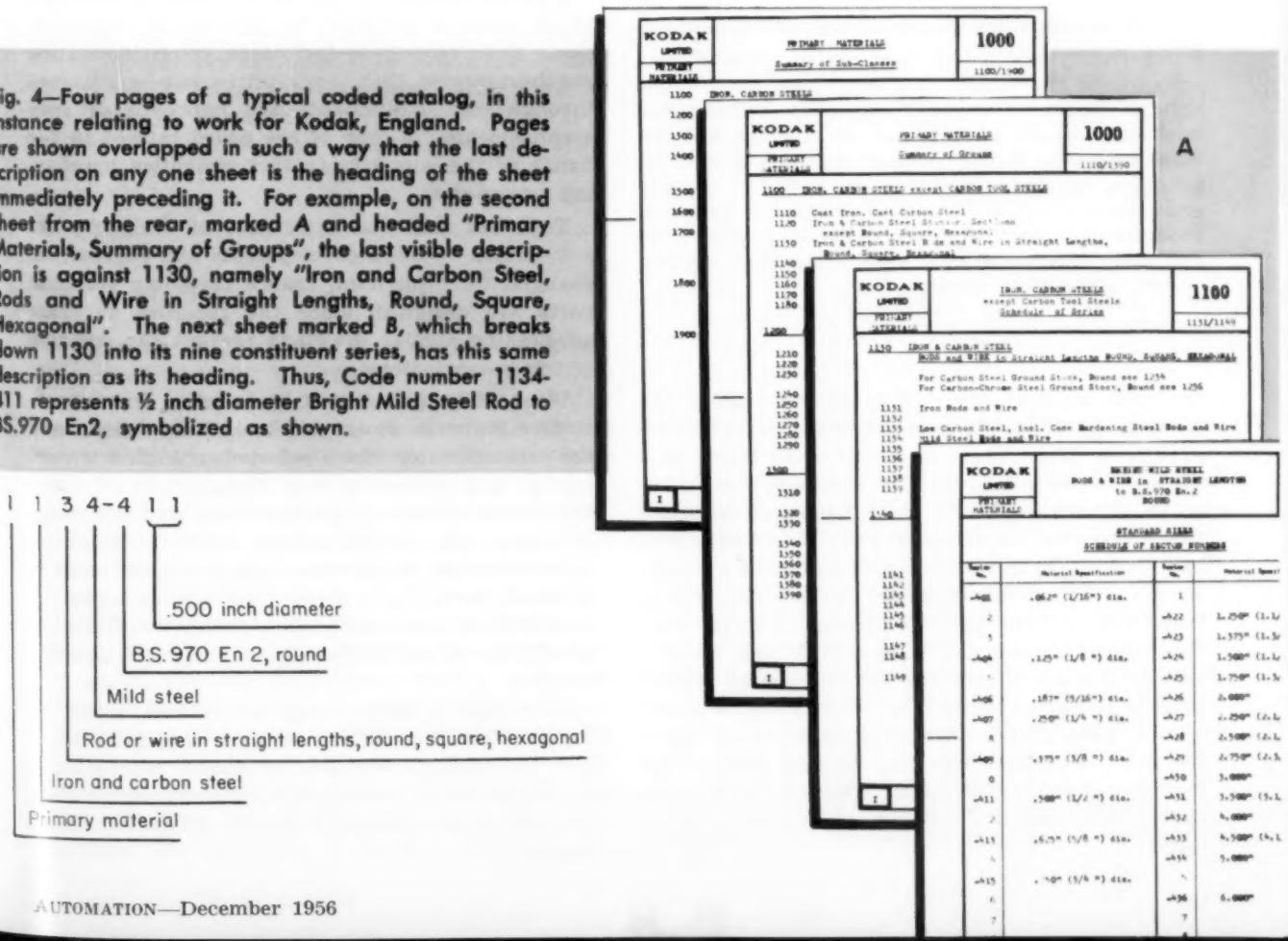


Fig. 4—Four pages of a typical coded catalog, in this instance relating to work for Kodak, England. Pages are shown overlapped in such a way that the last description on any one sheet is the heading of the sheet immediately preceding it. For example, on the second sheet from the rear, marked A and headed "Primary Materials, Summary of Groups", the last visible description is against 1130, namely "Iron and Carbon Steel, Rods and Wire in Straight Lengths, Round, Square, Hexagonal". The next sheet marked B, which breaks down 1130 into its nine constituent series, has this same description as its heading. Thus, Code number 1134-411 represents ½ inch diameter Bright Mild Steel Rod to BS.970 En2, symbolized as shown.

1 1 3 4-4 1 1
.500 inch diameter
B.S. 970 En 2, round
Mild steel
Rod or wire in straight lengths, round, square, hexagonal
Iron and carbon steel
Primary material

THE ANALYSIS OF MATERIAL COST OF A WORKS ORDER

Material Cost of Works Order

1134-113	M2905L	2. 0+
1124-160	M2905L	6. 6+
1124-278	M1108L	6. 0+
1134-162	M1109L	8. 4+
1325-124	M1103L	9. 9+
1355-180	BB807L	10. 6+
1124-204	M2615L	11. 0+
1335-309	M2421L	5. 8+
1375-207	M6882L	10. 6+
1124-147	BB806L	10. 0+
1154-171	M57070	1+
1366-131	M57070	3+
1335-311	M2438L	10. 0+
1335-304	M24360	2+
1134-109	M1364L	2.11+
1355-303	M1364L	3. 0+
1134-113	M2119L	10.10+
1154-140	M1110L	12. 0+
1154-180	N2905L	2. 0+
	Total cost	£6. 1. 6+

Cost of Copper Alloys in Same Works Order

1325-124	M1103L	9. 9+
1355-180	BB8071	10. 6+
1335-309	M2421L	5. 8+
1375-207	M6882L	10. 6+
1366-131	M57070	3+
1335-311	M2438L	10. 0+
1335-304	M24360	2+
1355-303	M1364L	3. 0+
	Copper cost	£2. 9.10+

Fig. 5—During a period of rising copper prices, a company wished to establish the effects of this rise in materials purchased. The upper tabulation indicates the total material cost of a typical works order and the lower tabulation the copper cost, quickly obtained by extracting all items containing the digit "3" (copper and copper alloy) in the second position of the Brisch code shown in the first column of the tabulation. Further quick analyses can be made to establish the cost of bar, sheet, plate or tube.

per year no more than 10 to 12 per cent of the relevant inventory value. Some quote a much lower figure. An analysis of actual costs based on a survey carried out in the United States some three to four years ago, and on information obtained from a number of firms in the United Kingdom, has shown that this annual cost is, on the average, 25 per cent of the inventory value. This figure takes into account the cost of capital, investment, insurance, accommodation, handling and maintenance, clerical procedures of purchasing, storekeeping and stock control, and the inevitable losses arising from deterioration and obsolescence. It is therefore somewhat alarming to find that an inventory valued at $10 million costs on the average the fabulous sum of $2½ million per year to maintain.

▶ Aid to Management

Brisch classification and coding provides a logical and sound foundation upon which to base a simplification policy which will ensure economic programing in the automatic factory. Variety can be reduced and, equally important, controlled. Every variety will normally require a minimum stock and for every variation eliminated, there is no need to increase the holdings of the remainder proportionately. A more economic inventory can be established and maintained, fewer bins are required and storage space is saved.

If items are stored in code order, a greatly improved stores layout is obtained. The location of each item is greatly facilitated since, in addition to identifying and describing each item, code numbers are, at the same time, location (bin) numbers in stores, and cross reference locator files are eliminated. Where mechanized stores accounting on punched cards is in operation or to be installed, up to as much as 50 per cent of punched card space may be saved.

Record keeping, together with procedures of receiving and issuing, is simplified. New warehouse personnel can be trained in a shorter time and demands on the time of the head storekeeper for instructional purposes are minimized.

Time required to draw stock is reduced since much preparatory work can be carried out beforehand, and time hitherto spent in identification due to misleading and ambiguous descriptions is saved.

Full knowledge of equivalents and alternatives of all items is available throughout the organization. Bulk buying is facilitated by consolidating requirements so that lower prices can be obtained through volume discounts and improved delivery arrangements. A copy of the coded catalog in the hands of the suppliers further simplifies purchasing procedures.

Technical skill and experience of designers are not curbed. Design developments and engineering changes, fully justified, ensure that only essential parts are designed, since the facilities to trace all existing similar drawings prevent the creation of unnecessary items.

When a demand cannot be satisfied from stock, similar items in stock can be quickly traced and the most suitable items selected, modified if necessary, and offered in lieu. Manufacture of small batches or special setups is avoided and the range of spares held can be reduced since the same requirements can be satisfied from a smaller variety of stock, particularly when parts are stored in the semifinished state and require one or two finishing operations to enable them to satisfy each specific demand.

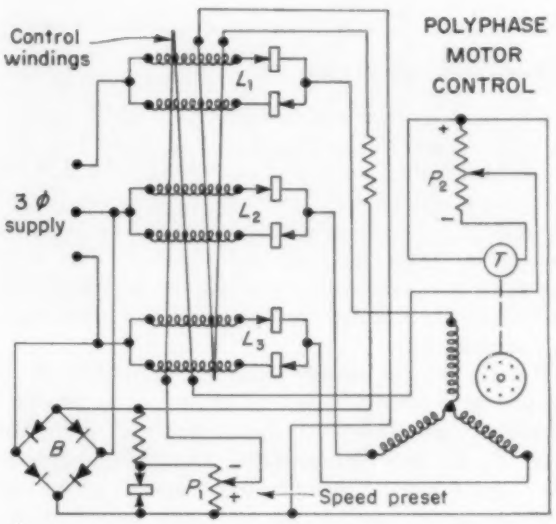
Reduction in variety and the rationalization in design which the Brisch method of classification and coding achieves are necessary prerequisites to the process of specialization and automatic work transfer between machines which are keys to automation.

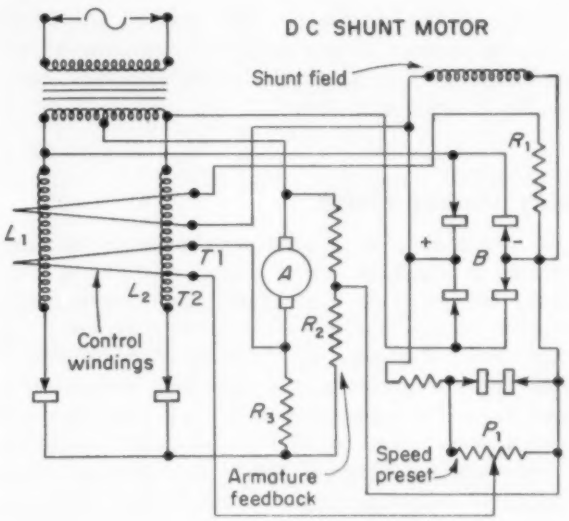
CONTROLLING MOTOR SPEEDS

By JAMES R. WALKER
Director of Research
Gemco Electric Co.
Detroit, Mich.

EFFECTIVE SPEED CONTROL of electric motors assumes added importance as industry adopts more automatic equipment. Control systems must not only provide means for adjusting speeds to different settings but also means for regulating speeds automatically to hold a given setting. This is an area well served by control circuits employing magnetic amplifiers.

It is to be noted that in this field, the magnetic amplifier once again must compete with devices employing vacuum tubes. Resistance to vibration, overall reliability and maintainability are but a few of the factors which favor the use of magnetic amplifiers for speed control systems described in this second of a series of six application notes on magnetic amplifiers.





Polyphase Induction Motor

The magnetic amplifier shown in the control diagram for a polyphase induction motor is a balanced full-wave, three-phase doubler with common control and bias circuits. Rotor speed feedback is supplied to the magnetic amplifier control circuit from a tachometer—voltage reference circuit. A speed range of 10 to 1 may be obtained with this control means. For stable control the motor required must be of the high resistance rotor type, thus the voltage versus speed characteristic is continuous and closely linear. It must be noted that an ordinary commercial induction motor does not exhibit these characteristics. The principal disadvantage in use of a speed control of this type lies in the necessity for a tachometer shaft speed indicator.

DC Shunt Motor

Magnetic amplifiers may be employed to regulate the speed of shunt type dc motors for sizes from 1/100 to many hundred horsepower. Amplifier configurations for this purpose quite naturally vary with the power requirements of the associated motor. In the case of motors less than 2 hp in size, a single phase magnetic amplifier can be used for supplying the motor armature excitation; polyphase amplifiers are used for motors larger than 2 hp.

With reference to the diagram, the speed regulating action is based upon the biasing of cores L_1 and L_2 from the field supply rectifier B through resistor R_1 so that the quiescent point lies in the central portion of the amplifier characteristic; an armature voltage component, existing across resistor R_2 is compared with a reference voltage existing across the speed control potentiometer P_1 modified by the voltage component present across resistor R_3 which is proportional to the armature current.

The relative control voltage polarities across the magnetic amplifier control terminals are so arranged that the armature voltage feedback obtained from resistor R_2 is opposite in polarity to the other two voltages existing between control terminals $T1$ and $T2$. Thus it is that a fall in armature feedback voltage resulting from an increase of mechanical load will cause the voltage across R_3 to increase and add in polarity to the preset voltage standard from P_1. This overall signal will cause increased saturation of amplifier reactors L_1 and L_2. Consequently, the speed of the armature will rise to its former magnitude thus returning the current in the control windings to its former con-

dition except for a slight increase in the control coil current necessary to maintain this increased load condition.

Speed regulation is obtained by holding the armature speed to that value which will assure closest correspondence between armature feedback voltage and preset standard voltage and accordingly result in a low error current in the control coil.

Ward-Leonard System

Certain applications of speed control systems in which several motors are to be used and controlled in a given system may quite efficiently employ a single induction motor to drive several dc generators each of which will furnish excitation for one of the equipment drive motors. The exciting field for each generator can be supplied from an individual magnetic amplifier of the type shown in the diagram.

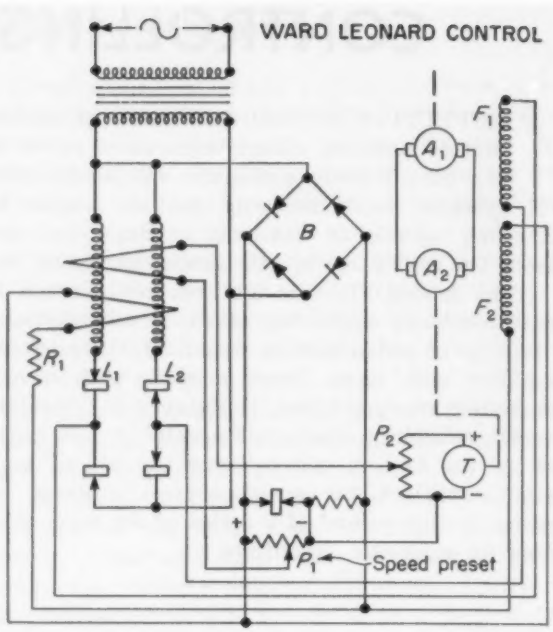
Here a double bridge magnetic amplifier is arranged in a feedback control circuit. The magnetic amplifier supplies field excitation to generator field F_1 in accordance with the requirements of the signal circuit composed of speed preset potentiometer P_1 and speed feedback potentiometer P_2. The speed range obtainable is approximately the same as the range obtained with the eddy current clutch. Electrical efficiency of the Ward-Leonard system is approximately the same as that exhibited by the magnetic amplifier shunt motor feedback control system.

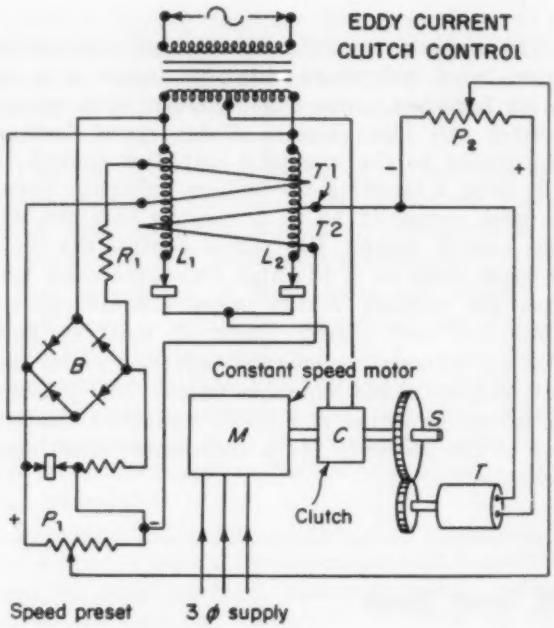
Eddy Current Clutch

A speed control capable of a large speed range utilizes a constant speed motor such as a polyphase induction or a dc shunt type, mechanically coupled to the load member through an eddy current clutch. Comparison of the speed range obtainable from a shunt motor feedback control with that from the eddy current clutch indicates that a maximum range of 10 to 1 is possible with the former while a range of 150 to 1 may be shown by the latter. A comparison of time required for regulation to be effected following a change in load condition shows that recovery of preset speed is attained considerably faster in the clutch type speed control.

As shown in the circuit diagram, operation of this regulator proceeds from the assumption that a magnetic amplifier, comprised of cores L_1 and L_2 in association with their respective rectifier diodes, is placed in the midsection of its control characteristics by means of the bias bridge B and dropping resistor R_1. The resulting output dc current which flows into clutch coil C causes rotation of output shaft S and tachometer T at some speed less than the output speed of motor M.

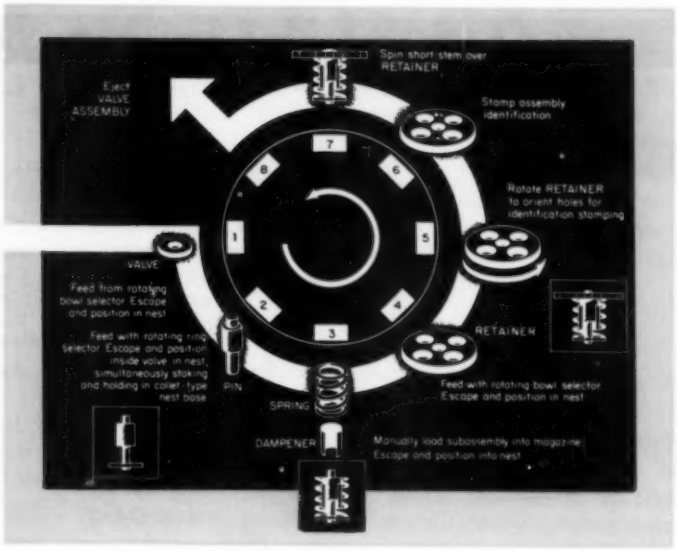
The voltage generated by tachometer T, and developed across terminals $T1$-$T2$, is proportional to the speed of shaft S. This generated voltage is compared with a portion of the standard voltage existing between the slider of P_1 and its right hand





end in an essentially bucking manner. The difference signal polarity which is obtained across the control input terminals $T1$-$T2$ is dependent upon the relative magnitude of the preset voltage and tachometer voltage. If the tachometer voltage is greater than the preset, then the voltage $e_{1\text{-}2}$ is of a polarity which will reduce saturation of reactors L_1 and L_2 in order to reduce the excitation of clutch C so that the speed of S may be reduced. Motor speed controls of this general type have been utilized with motors ranging in size to 5 hp.

The advantages of this system include: Use of small control amplifier, improved dynamic response, and large speed control range. Disadvantages to be noted are: Low overall efficiency and use of tachometer speed indicator.



PROJECT PROCEDURE

- **Data Collection**
- **Analysis**
- **Decision**
- **Procurement**
- **Installation**

AUTOMATED ASSEMBLY—3

To take full advantage of the technological advancements already accomplished in this field the user must consider the appropriate steps in achieving the goal. Once management is familiar with the principles, then procedures can be established and followed in the manner described in this final article of a series.

By **KENNETH R. TREER,** Gray Equipment Co., Cleveland, O.

MAXIMUM EFFICIENCY in management supervision is dependent upon a simple and logical procedure, whether it be purchasing, accounting or engineering. It is not necessary for the treasurer, vice president or buyer to understand the engineering details of a project if he can satisfy himself that proper steps have been taken to insure satisfactory results before signing the appropriation. Neither need the executive or administrative engineer delve into details if he insists on his department following an established procedure.

By way of example TABLE 2 entitled: "Approach to Automated Assembly Projects," lists five steps and the detailed matter to be considered as pertaining to each. Note that a joint responsibility is indicated in every step except the actual decision to buy, which can only be the purchaser's responsibility. This is stressed again in each of the sections following which discuss some of the problems encountered in each step of the project.

▶ Step 1—Data Collection

Too many automation projects are instituted at some point in the manufacturing sequence without careful review of the entire process. Frequently a single operation, or group of operations will be automated at desirable

TABLE 2—Approach to Automated Assembly Projects

STEP	1—DATA COLLECTION	2—ANALYSIS	3—DECISION	4—PROCUREMENT	5—INSTALLATION
RESPONSIBILITY	Vendee Vendor	Vendee Vendor	Vendee	Vendee Vendor	Vendee Vendor
DETAIL	Production routings Operational drawings Existing costs Proposed production Desired costs	Type of req'd automation Degree of automation Operational combinations Operational efficiencies Equipment costs Conversion probabilities Product design	Amortization Programmed equipment additions Product stability Available capital	Responsibility Cooperation Guarantees Payment	Equipment grooming Personnel training Maintenance

amortization rates, while a comprehensive survey of the entire process might have indicated an entirely different method or combination of operations which would have resulted in far greater savings, quality or control. Having removed the "cream" of the savings, further automation is often impractical resulting in a net loss of potential cost reduction.

A complete sequence of operations, operational drawings, material costs, labor rates, production rates, scrap and rework figures, existing equipment values, age and maintenance costs, burden rates, and schedule forecasts should be collected in one file before the analysis begins.

This is a good time, right at the beginning, to review the product design, materials and tolerances before an excessively "sharp pencil" requires an unnecessarily close tolerance or high finish. The equipment vendor should be brought in on this step. Make use of his experience in obtaining all of the data pertinent to the project. It is much too easy to skip over missing information later because it may be inconvenient to dig it out.

There are companies whose policy is to let out only as much information as they deem absolutely necessary. Perhaps the reason appears to be sound, but they do pass up the opportunity to add to their payroll, gratis, the experience of the vendor who is a specialist in his field.

In addition to existing production figures, desired production data should be listed. Often the preparation of this information will suggest other basic data which has been overlooked.

▶ Step 2—Analysis

Seldom is one man sufficiently experienced in all the phases of automatic assembly to individually arrive at the best answer to all of the possible combinations involved in a project. Evaluation of the data from step one should be undertaken by the plant management representative jointly with the vendor representative and staff. Usually many combinations of operations or methods will do a given job, but one will be the most satisfactory from all standpoints. A little conflict of opinions, likes and dislikes, at this point will do wonders.

Once again, product design, adaptability of parts to automatic handling, availability of suitable machine elements and the selection of optimum systems and sequences must be examined and reexamined to find the most satisfactory solution.

Very few products are originally engineered for automatic assembly. Simple changes, which may in no way affect the function of the product, may drastically reduce manufacturing costs and problems. The profit conscious executive insures that his design group cooperates with his manufacturing engineering and equipment suppliers.

The analysis should result in a number of conclusions and recommendations:

1. What kind of automation—cyclic or continuous?
2. How much automation? Where does the invested machine and labor dollar produce the greatest savings and quality?
3. What operational combinations offer the maximum benefits?
4. Is the product design best adapted for automation?
5. What equipment will do the best job? What is its cost investment, maintenance, labor and overhead?
6. What is the probable efficiency of the equipment? Is it so complex that it will be down too much of the time?
7. Will it be practical to convert a large percentage of the machine with product design changes? Is such conversion likely?

Over-automating is probably as bad, or worse, than under-automating. Too many parts-selectors in a sequence can result in excessive down time. As discussed in part 1, parts-selectors are percentage deals in that they operate somewhere

around 95 per cent of the time. The balance of the time may be lost due to "misses", track jamming, and other malfunctions inherent in these devices. Thus, 20 parts-selectors on one machine, each one down 5 per cent of the time, could conceivably result in the machine being down 100 per cent of the time. Actually under these conditions the down time would be more like 40 per cent, but this would be highly unsatisfactory in any case. In analyzing the individual problem care must be taken that the accumulated malfunctions do not exceed a reasonable 10 or 15 per cent of the available operating time.

Over-automating may be caused by other than the combination of too many functions. Frequently it is attempted to make the piece of equipment handle too many different kinds of parts. While versatility is desirable, where production does not warrant strictly single-purpose machines, extreme care must be taken that setup change-over time does not exceed 10 to 20 per cent of the running time on the shortest lots. A company may be able to justify 3 or 4 hours set-up time on an automatic screw machine for a 12 to 15 hour productive run. However, when an automatic assembly machine is set up the many interlocks, probes, gages, fixtures and other equipment hookups involved may easily eat up more time than other conventional factory equipment.

The analysis should result in equipment recommendations, quotations, proposed costs and all necessary data for management to make their decision.

Quotations are expensive to prepare, both for the buyer and for the vendor. It is not unusual to spend thousands of dollars on quoting a complex piece of equipment. It is neither fair nor good business for a buyer to ask several vendors for firm quotations on the same piece of equipment when such quotation costs are involved. In some fields vendors have charged for quotations. We feel this tends to restrict the customer's efforts toward acquiring new equipment. Such quotation charges should not be necessary if the buyer will make a policy of selecting one vendor to quote before the expensive stage of a firm quotation is reached. This can be done by means of preliminary surveys with several vendors, each of which may submit tentative quotes or estimates subject to exhaustive review of blueprints, samples, etc. Such a preliminary survey should give the buyer ample opportunity to determine which of his potential vendors is going to give him the greatest service and the most complete coverage of the problem.

The final proposal from the vendor should contain a functional description of the equipment together with estimated production rates, firm price and a well itemized list of the pieces of equipment which form the final machine. Layout drawings are many times supplied but the buyer must be careful that he doesn't insist on too detailed a layout. It is recognized that 25 to 50 per cent of the engineering of a machine must be performed in order to quote. Requests for too much detail may put the vendor in a position where he must ask for engineering charges and, at best, must specify that the layouts are tentative and subject to changes. Any other method of quoting must be guesswork and can result in some unhappiness sooner or later.

The analysis of the automation problem is completed and summed up with the proposal from the vendor and the appropriation request by the customer's engineering staff.

▶ Step 3—Decision

To buy or not to buy is a troublesome decision for many executives. Even more troublesome is deciding which to buy when several attractive projects are pending. Once all the available data has been analyzed and the conclusions and recommendations summed up, the executive must allot each project its relative urgency promptly to avoid losing the value of the effort.

A little conflict of opinions, likes and dislikes, at this point will do wonders.

Available capital determines most corporate machine programs. Some firms appropriate a fixed amount for machinery expenditure for the following year, which is distributed to the projects having the fastest amortization rates until the money is gone. Other firms establish an optimum amortization period and approve all projects falling within that self-liquidating time, obtaining capital as it is required.

Planned equipment addition and replacement is almost a must in today's technological competition. Advances in machining, grinding and forming processes leave assembly operations in the highest cost bracket. A planned assembly equipment program, based on a comprehensive survey of present

Available capital determines most corporate machine programs.

and probable requirements and available methods should be part of every executive's thinking.

Application of a standard "test" to each project should offer a fair comparison of project urgency to simplify the executive's decision on both *whether* and *what* to buy subject to available capital. All manner of tests are used, from rule of thumb and intuition to highly complex individual formulas. One accepted test is the MAPI (Machinery and Allied Products Institute) formula which takes into consideration all of the major factors involved in equipment purchase decisions.

While the decision is properly the buyers sole responsibility, the vendor should be able to, upon request, offer considerable aid in the planning. No ethical vendor wants to sell an item which does not benefit both buyer and vendor and the wise buyer makes use of his vendor's knowledge.

▶ Step 4—Procurement

Procurement is a joint action between vendee and vendor toward a mutually profitable solution to the buyer's problem. No business transaction leads to a satisfactory relationship unless both parties profit by it. Mutually profitable transactions are most likely when both parties hold the solution of the problem to be the most important part of the relationship. Buying on price alone inevitably leads to buyer dissatisfaction. Selling just to meet a quota leads to mutual dissatisfaction. Most reputable firms with efficient purchasing procedures recognize these principles and live by them. Most equipment manufacturers who expect the better kind of business will not go after an order not based on these principles.

If you build your own equipment, the same principles apply—both in obtaining the machine from your machine group and in obtaining component parts. Establishing a qualified design and build group, however, is a costly and long-term project which few but the largest firms can afford, assuming that you take into account all of your costs, time and effort. Much of the finest assembly equipment in the world is produced by large firms solely for their own use, largely because few suppliers can afford to take on the multimillion dollar projects and few firms will give a supplier the latitude and funds with which they trust their own groups.

If you buy your equipment, there should be no question of authority and responsibility when the project is instituted. If one vendor is responsible for recommendations, design, construction and function of the machine, be prepared to give him your full confidence and co-operation—not just in data and money, but in working out the many problems that pop up as the project develops.

It should be recognized that most automation projects begin with considerable study of the problems by the buyer, sometimes covering years. Then the vendor is handed the problem with weeks or even hours in which to answer the problems others have studied so long. Every question, every problem, every conceived answer should be presented to the vendor when he is called in. Failure to do so should be considered a contributory responsibility on the part of the buyer, even as though the vendor were part of his staff. Seldom does the buyer fail to recognize this fact, but sometimes the understanding is difficult to reach and occasionally an unhappy situation evolves between sincere and honest people.

When the responsibility for surveys, designs, fabrications and "grooming" of a project is divided between several vendors or buyer staff and vendors, the buyer should be prepared to accept considerable responsibility in approving each step. In effect, this releases the design supplier upon design approval and the fabricator is responsible for just material and workmanship, etc. Much business is satisfactorily accomplished in this manner, but only when responsibilities and authorities are clearly understood in advance.

Problems may pop up as the project develops.

Performance guarantees should be expected from the responsible supplier who has been given full responsibility and authority as well as co-operation. A "work-or-no-pay" basis is common on small to medium size projects. Depending upon the size of the purchaser and vendor, larger projects are based on progress payments—so much after design, after fabrication, upon delivery and upon satisfactory production runs. This in effect legally splits responsibility to some degree, but the ethical supplier feels responsible and carries out his best efforts.

Whatever purchase terms are arranged, they should be considered as an expression of confidence rather than a sword of Damocles. A satisfactory problem solution resulting in mutual profit is the only goal.

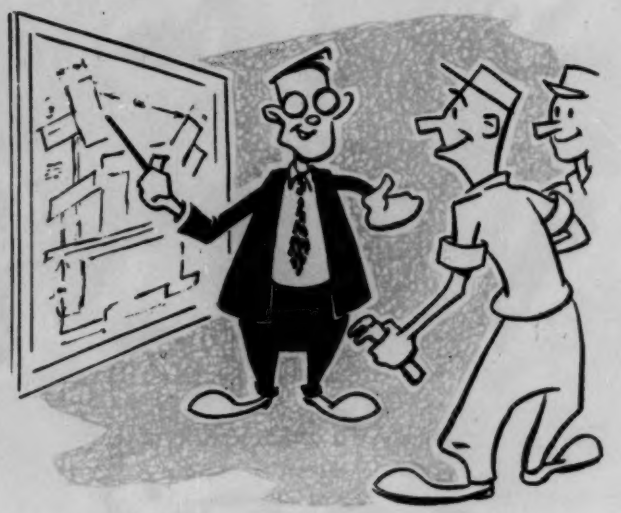
▶ Step 5—Installation

It is a rare machine, specially designed and built, which can be put into production without a grooming period on the line. One large firm has a department solely for running-in automated equipment on a production basis before finally moving it to the production department. Smaller organizations must anticipate a period of time on production before all of the "bugs" are worked out of the machine. Impatience must not be permitted to condemn the vendor who is just as interested as the buyer in completing the project.

Hopper-feeds, free-moving parts and equipment require run-in periods far longer than mere acceptance trials to "break-in". The exact output of most hopper-fed machines is very difficult to predict. The vendor usually quotes conservatively on production guarantees. Usually the buyer gets a higher output than anticipated and generally keeps stepping up the machine until it reaches the point of diminishing returns which is his free bonus. On the occasions when the quoted production rate isn't quite met, a little reflection on the part of the buyer may indicate that he has his share of value received through the law of averages.

Operator and maintenance employee training becomes a factor in this day of complex hydraulic-electric-mechanical-pneumatic systems. Contrary to many beliefs, automation does not reduce the required technical ability in the shop. While a machine feeder need know less, it is generally decided that the operator should know more in order to reason out minor malfunctions. This situation prevails in spite of all of the indicating interlocks and protective devices now applied to a finished machine. The trained operator can clear the minor malfunction of a jammed feeder track in seconds, where the untrained operator would be lost until the set-up man arrived.

This is good. New methods are usually suspect in the shop. Your decision to upgrade the personnel assigned is a management opportunity to promote personal pride and responsibility, and to generally do something about the much lamented labor attitude. You will see these opportunities as you examine their possibilities.



Operator and maintenance employee training becomes a factor in this day of complex hydraulic-electric-mechanical-pneumatic systems.

Shop supervision and plant engineering attitudes also contribute much to the success or failure of the automation project. The normal resistance to change offers another challenge—and opportunity for intelligent management progress. Advance planning incorporating the aid and advice of labor, supervision and engineering serves to instill a feeling of sharing in the project and adds tremendously to a speedy, effective automation installation.

▶ Proceed

Enlightened management, that gives due consideration to the five steps of automated assembly projects that have been discussed here, can readily establish an operating procedure whereby the organization can successfully achieve automated assembly. The field of automatic assembly is broad indeed and employs many talents. But with organized effort some combination of the many available techniques can be devised that will yield profitable improvement in assembly processes and thereby enhance your competitive position.

What's Your Problem?

DO YOU have a knotty problem in your automatic operations or those you plan to install? Perhaps our experience and knowledge of this field can help establish contacts leading to practical solutions.

To avail our readers of automation information and tap the vast reservoir of practical know-how across industry, the editors have been performing a special service. If, in planning new automation systems, unfamiliar or new requirements present obstacles, write us concerning your needs and we shall be glad to assist in procuring pertinent data on present practices or in ascertaining suitable equipment obtainable from industrial specialists and consultants. We have been able to help in solving many problems, perhaps we can help you in yours.

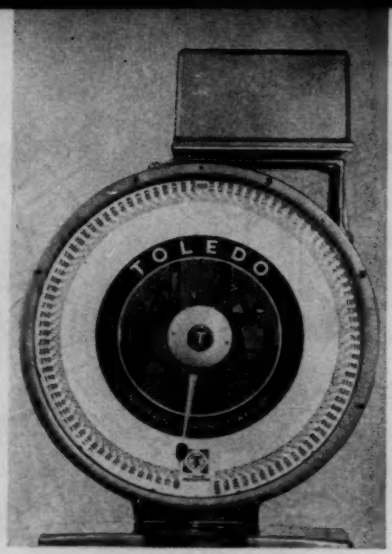


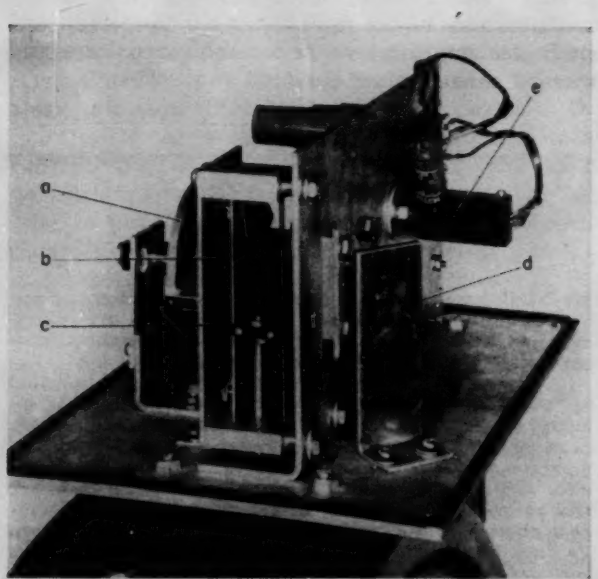
Fig. 1—Direct digital scanner is mounted on top of the dial housing of an industrial scale.

The weighing system described in this article emphasizes the industrial trend toward automatic sensing, transmission, indicating and recording of pertinent processing data. How does it work—an industrial scale has been provided with a digital scanner. The result—weighing joins the impressive list of operations capable of being integrated into a data processing system.

PHOTOELECTRIC SCANNER PERMITS

REMOTE WEIGHT TRANSMISSION

WEIGHING AND DATA PROCESSING are closely allied operations in many industries. Developments in equipment insure that integrated systems of weighing and data processing are not only possible but also highly practical. An example of such an advancement is a digital scanner system introduced by Toledo Scale Co. Very generally, the system consists of a means of converting the weight sensed by the scale to pulses which in turn are received by electronic decade counters; signals from the counter then pass into a translator which puts them into the proper form for operation of a variety of remotely located indicating and recording means. A significant factor is that notation of weights is no longer limited to either close proximity to the point of origin



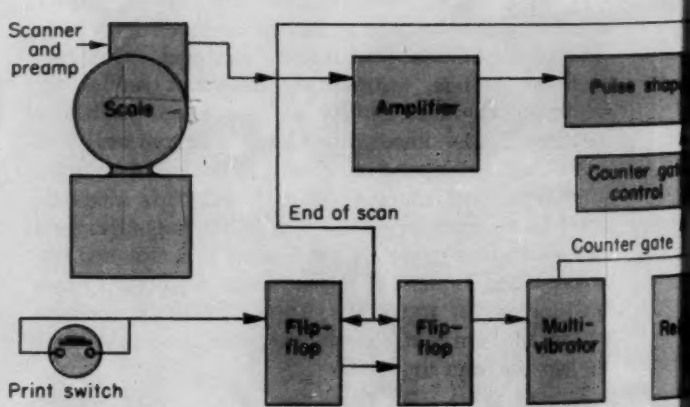


Fig. 2—Basic elements of the scanner, shown in picture with ho removed, are: (a) rotating light source; (b) rectangular transp chart; (c) shutter; (d) mirror and (e) photocell. Block diagra dicates relationship of components which take weight indication convert them into light pulses and then into electric pulses.

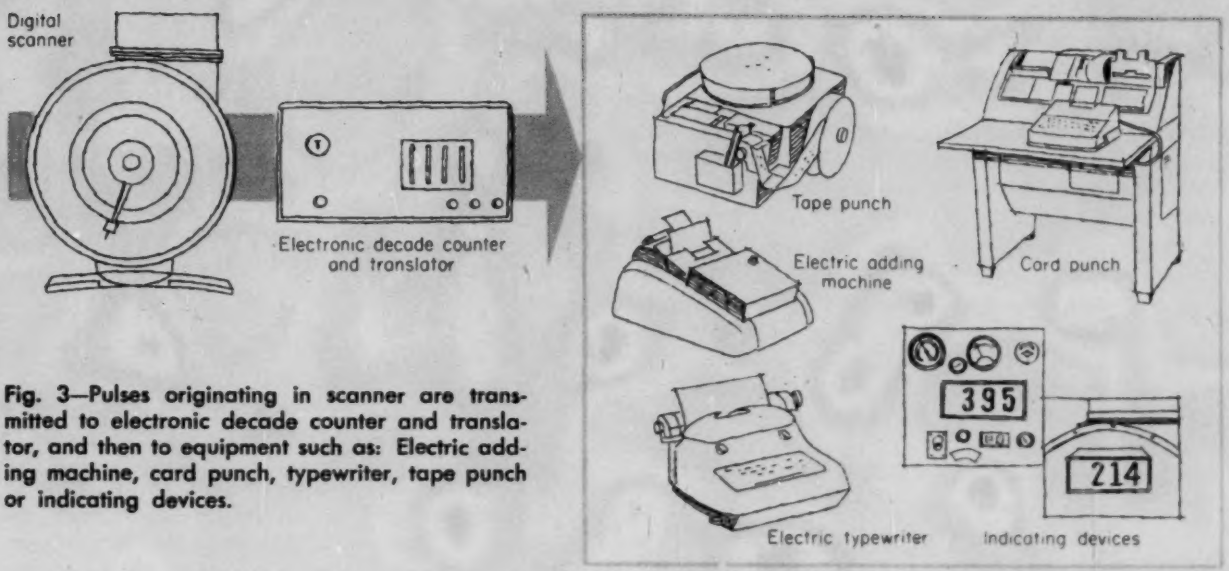


Fig. 3—Pulses originating in scanner are transmitted to electronic decade counter and translator, and then to equipment such as: Electric adding machine, card punch, typewriter, tape punch or indicating devices.

or to only one type of recorder or indicator. An additional important consideration is that such a system eliminates the possibility of error by eliminating the need of an operator in reading of a scale or transcribing of weight data.

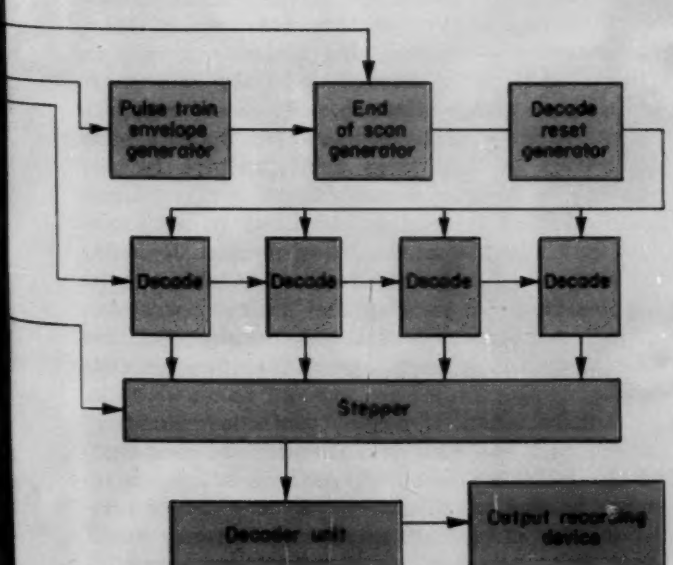
▶ Weight In Digital Form

The scanner, a unit which is located above the dial housing of the scale, is mechanically linked to a pendulum mechanism of the scale. In the scanner, a motor driven light source rotates such as to scan a small transparent chart, marked with lines, 120 times a minute. When weight is applied to the scale, a shutter, operated by the dial mechanism of the scale, exposes lines on the transparent chart equal in proportion to the weight sensed. The exposed lines interrupt the rotating light beam, thus creating pulses of light. These pulses are magnified and reflected by a mirror onto a photocell and transmitted as electrical pulses to the electronic decade counter.

It is to be noted that the digital conversion is made at the scale, thereby eliminating any intermediate conversion steps between the scale and data handling equipment. The signal is taken from one of the few points of the scale where the motion is linear with respect to weight. Mechanical connection between the scale and scanner does not introduce any measurable friction into the system and thus the original accuracy of 0.1 per cent of dial capacity is preserved.

With a digital signal representing the scale reading, it is apparent that the weight data can be recorded directly on any of several types of office machines: Punched card tabulators, adding machines, electric typewriters, etc., or stored on tape for future playback. The weights can also be indicated remotely in scoreboard form by numerals which are electrically illuminated. In using this equipment, data may be recorded automatically or the time of recording may be selected through the use of an actuating button. Intermediate equipment can automatically deduct tare weights or introduce multiplying factors if desired.

Typical industrial applications of the system include listing and totaling of items passing over a roller conveyor or overhead track; inserting weight data in punched card billing records; tabular listing of ingredients going into batches; and remote supervisory checking of weights.



▶ Examples of Applications

The versatility and advantages of the direct digital scanner can be appreciated best by reference to actual applications. For example in a billing operation, the scanner, with an IBM machine and a ticket printer (electric adding machine or typewriter), is used to obtain complete weight data for billing records. In this system,

the gross weight is transmitted by the Toledo digital scanner to the computing unit. Simultaneously, the tare weight and moisture factors are fed to the computing unit from a prepunched IBM card. The computing unit automatically subtracts the tare weight from the gross weight and multiplies the difference by the moisture content factor. The result is the net billing weight.

This data is duplicated on a second IBM card to which is added a serial number; at the same time the ticket printer prints all of the information on a shipping ticket. End result is a record containing complete data including gross weight, factored shipping weight and a serial number—all obtained by an operator pressing a button without the necessity of taking any readings or doing any computation.

In another example, digital scanners and an electric typewriter are used in conjunction with an automatic batch control system to obtain complete batch weight data. This system contains 22 scales with controls for weighing preset amounts of materials in proper sequence. Each scale is equipped with a scanner, which transmits to the electric typewriter the actual weight of each ingredient delivered. A data input station provides manually set switches for date and automatic stepping switches provide the batch number and time.

This system in addition to electrically interlocking all scales, gates, and feeders automatically furnishes complete data for each batch including number, date, time, weight of each ingredient and total batch weight. This provides management with complete typewritten records of each batch delivered.

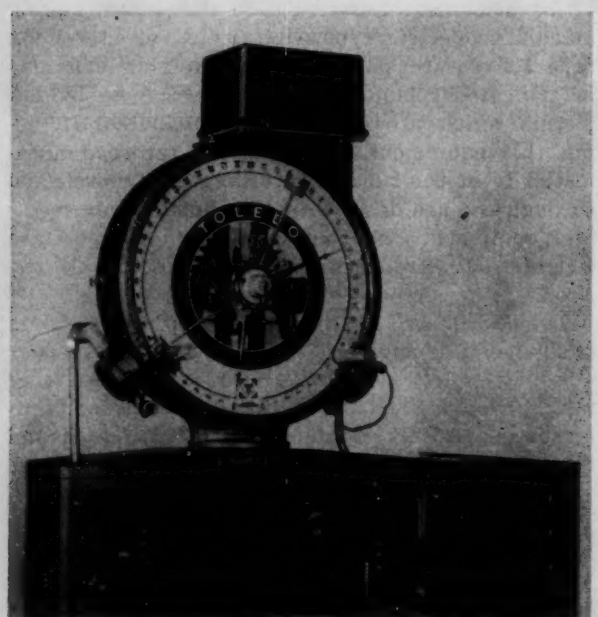


Fig. 4—Type of scale used with automatic batching system, in addition to direct digital scanner which transmits weights to recording or indicating devices, can be equipped with photoelectric cut-off (note dial) that controls the weighing of preset amounts of material.

PACKAGING IS A PRODUCTION PROBLEM

By C. D. WELSHENBACH
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PACKAGING, today, is part of the production line and is no longer considered the special preserve of the shipping department. Why the change? In attempting to meet the rising cost of both labor and materials by increased production, industry has turned to automation. Old packaging methods cannot match the pace of accelerated production. Invariably as the production rate increases, inefficient packaging methods are spotlighted. Packaging problems must be solved if savings realized through automation are not to be nullified.

To satisfy the requirements for faster and more economical packaging, manufacturers are solving the problem through a unified approach. Rather than consider packaging a process apart from the manufacture of products, packaging should be considered an important part of the production line — packaging problems are production problems. As a means of solving the problems, many manufacturers are establishing packaging committees composed of representatives of packaging, production, shipping and management. Through co-operative action they arrive at the best solution to the problem.

One indication of the work being done by packaging committees, and others charged with increasing packaging efficiency, is found in the increased emphasis being placed on package standardization. Studies have revealed that while manufacturers were standardizing production methods and products, little thought normally was given to package standardization. However, reappraisals of package requirements often indicate near-duplication of box sizes and excessive interior packaging. In many cases it is found that a single standard package can be designed to accommodate multiple sizes and styles of product. Reducing the number of required sizes to the minimum facilitates standard packing and sealing operations, simplifies inventory and allows the manufacturer to take maximum advantage of suppliers' quantity prices.

Standardization through "controlled quantity" packaging is enabling manufacturers of component parts and those who ship bulk products to increase packaging efficiency. By the aid of careful analysis of past shipments and customer usage, these manufacturers are standardizing packaging

Fig. 1—Large appliances are quickly packaged in regular slotted cartons with aid of equipment developed by Hinde & Dauch.

by increasing or decreasing the quantity now shipped in each container. For instance, a large chemical company found that a powdered chemical shipped in 100 lb lots was ultimately emptied into 1000 lb hoppers for storage and mixing. Through a co-operative effort of the box supplier and user, a 1000 lb palletized box was developed to replace the smaller containers. The company reduced packing time by eliminating multiple filling and sealing operations and saved additional time through elimination of stacking and loading operations required to palletize equal quantities of chemical in small containers.

Changing the packaging material is also providing industry with more efficient packaging programs. An example is found in the nail industry. When the corrugated box replaced the traditional wooden keg, nail mills gained 30 per cent more floor space in their warehouses, cut package set-up time and simplified handling and packing. Receiving the boxes in knocked-down form in palletized loads provided easier handling and freed valuable space for production facilities. Easier to handle, and more readily transported on roller conveyors, the boxes are packed, weighed and closed in a minimum of time using straight line production methods. Conventional shape of the package keeps boxes in line on conveyors and eliminates jams. Faster weighing is possible by setting scales at a constant tare weight since all corrugated boxes weigh the same. Too, the rectangular shape facilitates closure and easier palletizing.

Changes in packaging equipment are also answering industry's problems. In the appliance industry as in other industries, automated production lines necessitate the need for an economical and efficient method of packaging. The regular slotted box and various sealing machines offer a limited degree of automatic packaging but require considerable floor space and multiple handling operations. The problem for the industry is to find a better way to load and seal the box. The normal way to load the regular slotted box is to fold in two of the flaps and lift and place the appliance in the box from the top. The box is then conveyed to the sealing machine which applies glue to the flaps and plows them shut. An alternative method utilizes a three-piece telescoping box of tube and cap design. By means of a short break in the conveyor, the appliance is seated on the bottom cap, a tube is dropped over the appliance and the top cap added. Closure is effected by interlocking and steel strapping the flanged tube and caps. But these methods needed to be improved upon.

Illustrating the improvement which new equipment brings to integrated packaging is a closing and sealing machine developed by Hinde & Dauch. Specifically designed to utilize regular slotted boxes, the equipment provides manufacturers with faster packaging, a 30 per cent reduction in packing labor and savings in valuable floor space. Packaging becomes a straight line operation — part of the production line.

With the equipment, which comprises a bottom flap closing mechanism and a new method of sealing the flaps, the box is placed over the product and the bottom flaps closed mechanically beneath the product. Excessive line length, required when plowing the glue-covered flaps shut, is no longer needed as the equipment closes flaps instantaneously. In addition to simplifying appliance packaging, the equipment can be applied to the packaging of furniture, filing cabinets, air conditioners and other products adaptable to straight line packaging methods.

Modern packaging methods and techniques are progressing rapidly and must continue to improve to match the accelerated pace of automated production. As an answer to the problem, the trend, now in its infancy, is to regard both product and package as a single unit of design. Engineers must consider how to package the product as well as manufacture the product. Only through such a unified approach will true integrated packaging be successful.

Fig. 2—Two smaller sections of conveyor swing upward to close bottom flap of box and support appliance. The two cantilevered plates, which have been supporting appliance, will withdraw and carton will be moved to gluing operation.

AUTOMATION SPEEDS GRINDING BETWEEN CENTERS

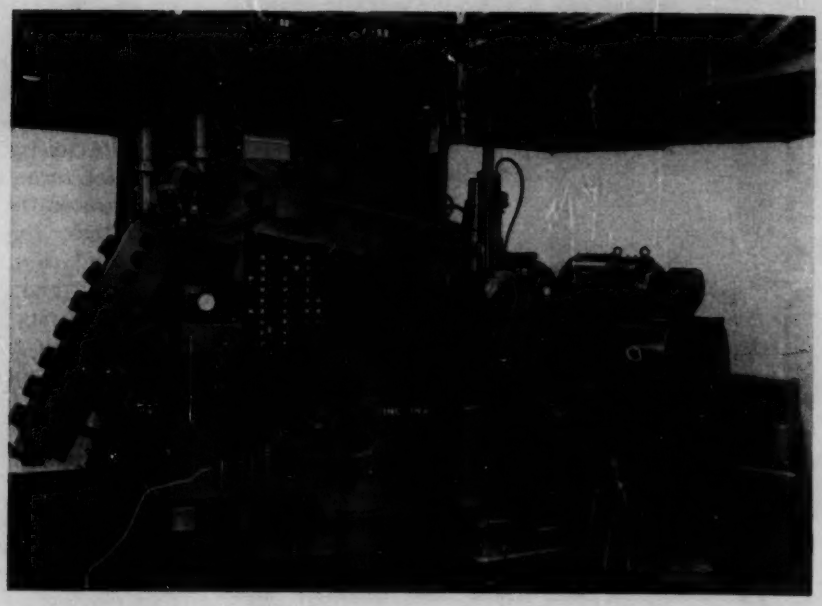
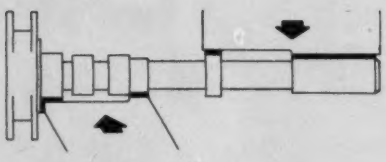


Fig. 1—Automated two-wheel grinder that loads parts between centers, grinds to size, unloads, trues and feeds wheels automatically. Five surfaces can be ground on 70 shafts in 50 minutes.



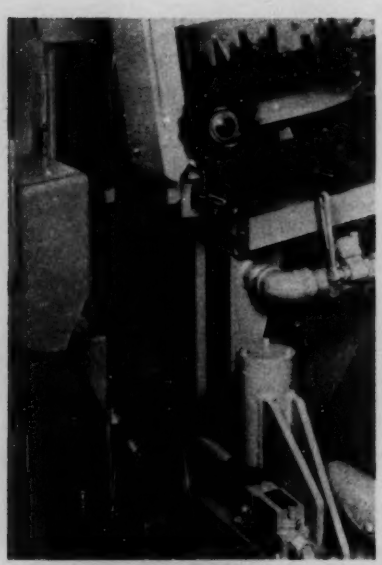


Fig. 2—This conveyor incorporated in the machine brings the workpieces to the hydraulically operated lowering mechanism that lowers the shafts and positions them between centers. After grinding, the parts are unloaded onto a cradle type chute and slide to the discharge point.

GRINDING BETWEEN CENTERS is normally a slow, manually loaded and manually controlled operation, but Cincinnati Milling Machine Co. has built an automatic centertype grinding machine to grind four different diameters and one shoulder on about 70 automotive transmission shafts per 50-minute hour. The plunge type grinder, *Fig.* 1, automatically loads the parts on centers, grinds to desired gage indications, unloads, dresses its two wheels, and compensates for wheel wear.

Workpieces move on a conveyor to a hydraulic lowering fixture, *Fig.* 2. This elevator type fixture lowers one part per cycle and positions it between the centers. Then the centers advance, locate and rotate the workpiece for grinding; gages move into contact; and the wheel heads advance rapidly. As the grinding wheels move in, removing stock from the part, the gage mechanism shifts the machine into extra slow feed approximately 0.001 inch above size. The instant the work reaches desired size, the wheelheads are retracted in response to another gage signal.

During the grinding cycle the lowering fixture returns to its loading position and another shaft is transferred from the supply conveyor to the elevator fixture in preparation for the next cycle. After a shaft has been ground to size, it is automatically unloaded onto a cradle type chute. The chute lowers the finished shaft so that it slides into a discharge chute. The unloading fixture then returns to its station beneath the part being ground.

Efficient wheel dressing is provided by automatic profile truing devices located behind each grinding wheel. After a preset number of pieces have been ground, the machine cycle is automatically stopped and the wheels trued to correct profiles. Reduction of wheel diameters during wheel life does not decrease surface speeds of the wheels, because this machine is equipped with automatic wheel speed compensating devices which increase the speed of the grinding wheel motors in proportion to wheel diameter decreases.

Automatic advance of the wheel slides continuously compensates for reduction in the diameters of the wheels, and as a result, cycle time remains constant instead of increasing as the wheels become smaller.

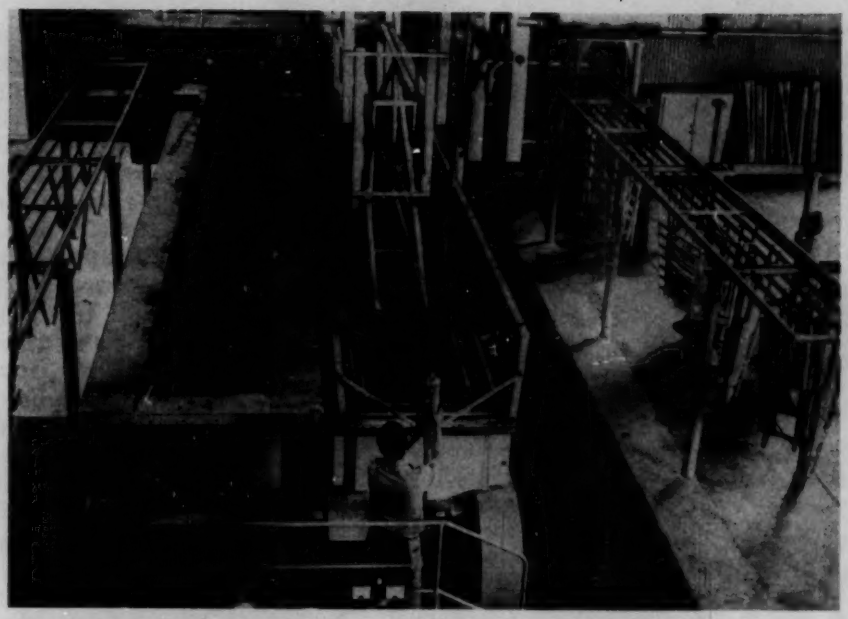


Fig. 1—This two-tank installation enables Douglas to completely clean, surface treat, and dry aluminum parts. Washing, rinsing, and Alodine treatment can all be performed automatically in the "Auto Cycler", the single tank into which the rack of parts is being lowered. Different process solutions are pumped to the parts rather than the parts moving to various tanks of solutions.

PUSHBUTTON METAL TREATING

Inefficient batch processing methods can often be replaced by continuous processing techniques, but sometimes the most practical plan of improvement is to develop automatically controlled equipment while retaining a batching cycle.

By **GILBERT C. CLOSE** Hawthorne, Calif.

AUTOMATIC FACILITIES for cleaning and treating of aluminum parts have been designed and installed at the Torrance, Calif. plant of the El Segundo Division of Douglas Aircraft. The new equipment does in two processing tanks all the work that formerly required ten processing tanks, and occupies a total of 600 sq ft of floor space as against the 2000 sq ft of floor space occupied by the system it replaced. Considerable time is saved when using the new equipment since most of the time required to transfer the work from tank to tank is entirely eliminated.

One of the tank units is dubbed the "Auto Cycler", *Fig.* 1, and is used for all the process cycles involved in the Alodine treatment of aluminum and for all treatments that precede and follow anodizing. The other tank unit, *Fig.* 2, is a rather conventional anodizing tank, but it is tied in with the handling system of the Auto Cycler.

The Auto Cycler reverses the batching procedure usually followed. Instead of the work being moved from tank to tank as different processing solutions are required, the work stays in a single covered tank and the processing solutions are introduced in the order of their requirement. The solutions enter into ten troughs equally spaced along the bottom of the tank. Each trough contains a rotor-type impeller, *Fig.* 3, driven by a 7½ hp motor, which hurls the solution at high velocity upward against the work. As each treatment phase ends, drains open automatically and allow the solution to leave the tank. A water rinse follows each chemical treating cycle to assure a clean tank for the next processing step. After the final liquid cycle, hot air is admitted into the tank to dry the work.

Controls for the Auto Cycler provide for three fully automated cycles, each actuated by a single

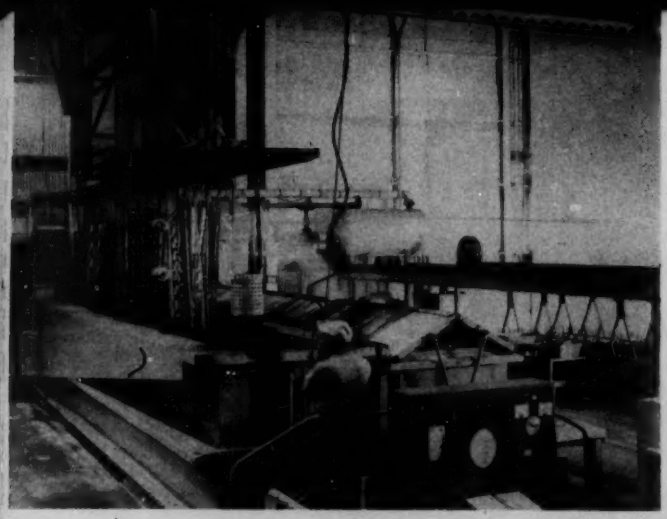


Fig. 2—After preliminary cleaning in the Auto Cycler, when parts specifications call for anodizing, the rack of parts is moved to this anodizing tank for treatment. After anodizing, the rack of parts returns to the Auto Cycler for a further automatic processing cycle.

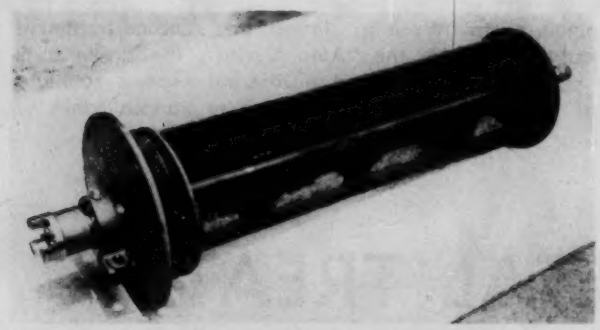


Fig. 3—Ten impellers like this one are located in troughs along the bottom of the Auto Cycler. When the various solutions are automatically metered into the troughs, the impellers hurl them upward against the work. The troughs are drained automatically at the end of each processing phase.

pushbutton. One circuit controls the anodic preparation cycle; a second the anodic finish cycle; and the third an Alodine preparation cycle. Pushing any one of the pushbuttons starts the complete treatment cycle indicated: The proper valves are opened at the proper time to allow the required solution to enter the tank troughs; timing is automatic; and after a processing phase is completed, drain valves open to allow the solution to leave the tank.

The anodic preparation cycle requires 350 seconds; the anodic finish cycle 480 seconds; the Alodine preparation cycle 1190 seconds. This includes hot air drying time where required.

Only break in the automatic sequence of metal treating comes between the anodic preparation cycle and the anodic finish cycle when, of course, the work must be transferred from the Auto Cycler into the anodic tank, then back again. But even this transfer is accomplished from the control panel, and timing of the anodic processing cycle is also a control panel function.

Alodine treatment solution is the only solution reused in the Auto Cycler and is stored in an adjacent 180-gal tank where it is automatically maintained at the proper processing temperature. During the Alodine treatment cycle, this solution is pumped from the storage tank into the Auto Cycler troughs, then circulates back into the storage tank again.

During the cleaning cycle, a highly concentrated soap solution is automatically metered into the water entering the Auto Cycler to form a cleaning solution of the proper strength. After the cleaning cycle, this solution is drained away and not reused. The concentrated soap solution is kept in a 105-gal storage tank near the Auto Cycler.

Work is handled into and out of the system by means of a special twin-track overhead hoist. The Auto Cycler is equipped with a solution-tight cover which automatically closes and clamps in place at the start of each processing cycle. Fumes from the anodic tank are eliminated by a water wash. A steam heat exchanger is used to provide heat for the processing solutions and warm air for drying.

The new system is designed for safety throughout: The cover on the Auto Cycler cannot be opened until a processing cycle is completed, and it is impossible to remove work from the anodic tank prior to completion of the 40-minute anodic cycle because the descending crane hoist will interrupt an electric eye beam, thus cutting the current to the hoist motor until the cycle is completed. The heavy contacts furnishing the current for anodizing close automatically when the work is lowered into place, and open automatically when the cycle is finished.

Exhaustive preproduction tests assured both Douglas engineers and government inspectors that the motorized impellers, hurling the solutions upward from the bottom of the tank, would give complete work coverage provided certain precautions were observed while hanging or basketing the work for treatment. And, of course, the parts must be hung or basketed in a manner to provide good drainage between the processing cycles.

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Earlier in the year, the author described the planning phase of an overall automation project involving a special plant for automatic production of a component critical to Army Signal Corps equipment. At that time the plans foresaw the need of and provided for the creation of special automatic equipment—part of which has now been developed and is described herein.

Fig. 1—Console and associated equipment which comprise the automatic x-ray sorter. Console contains mechanical unit and operator controls. The racks contain the high voltage x-ray supply and electronic control circuits.

PLANNED AUTOMATION RESULTS IN SPECIAL AUTOMATIC SORTER

By L. V. WISE
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Bulova Research & Development Laboratories Inc.
Woodside, N. Y.

UNDER SPONSORSHIP of the Army Signal Supply Agency and in co-operation with the Signal Corps Engineering Laboratories, Bulova Research and Development Laboratories is carrying out a production engineering program covering the mechanization of certain manufacturing processes for quartz crystal units. The crystal units are for use in military electronic equipment (See—AUTOMATION, March and April 1956). Of the special machines necessary for this program, one completed item typifies both the general approach of the program toward mechanization and the resultant equipment which is being developed. This device is the automatic Crystal Blank X-Ray Sorter, *Fig.* 1.

As an intermediate manufacturing operation, the x-ray sorter automatically measures and sorts the crystal blanks according to orientation of cut. It does this at a rate of 43 blanks per minute and with an accuracy of 20 seconds of arc—about 10 times faster and 5 times more accurately than a skilled operator using methods standard to the industry. In keeping with the overall plan which envisages the use of the plant and equipment under emergency conditions, all operator skill has been eliminated with the machine operator's duties being reduced to the loading and unloading of cartridges filled with the crystal blanks.

The Problem

Quartz crystals for use as piezoelectric resonators are cut from natural quartz stones in accurate orientation with respect to the natural crystal axes, *Fig.* 2. The orientation controls the characteristics of the finished units, and in particular the Z-Z′ angle controls the temperature coefficient of frequency. This angle is particularly critical, and it is usually held to plus or minus 3 minutes of arc in the finished unit, if possible, for the CR-18/U and CR-23/U crystal types for which the mechanized plant is being designed. With the present state of the quartz cutting art, it is not possible to control the Z-Z′ angle closely enough so that all blanks are produced within the desired angular specification for a specific frequency. But the blanks produced can be sorted into ranges of Z-Z′ angles which give temperature coefficients close to zero for different nominal fre-

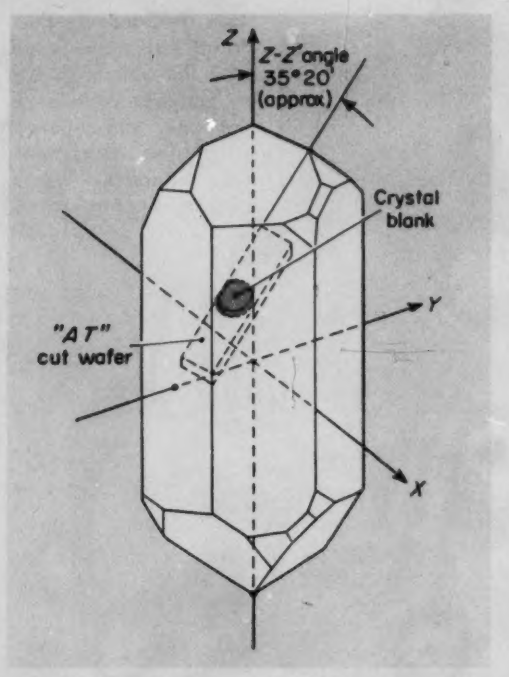


Fig. 2—Stones used as raw material have natural crystal axes. Crystal blanks must be cut from the stones with accurate orientation relative to these axes to obtain the required characteristics. The Z-Z' angle is especially critical in temperature-frequency characteristics.

Fig. 3—Flat on crystal blank is used for orienting the crystal in the x-ray sorter and in subsequent processes.

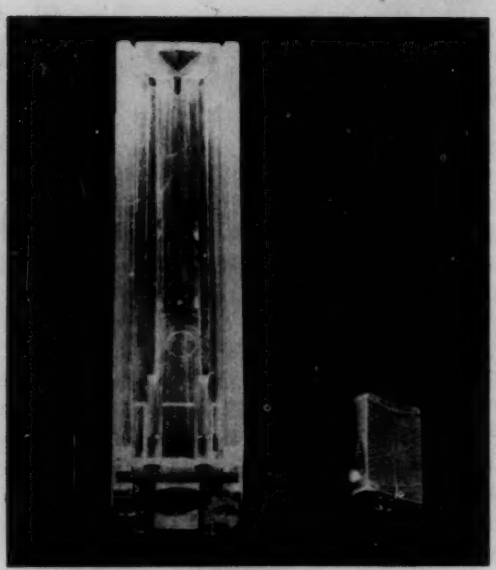


Fig. 4—Cartridge used as a collector, storage device, and dispenser throughout the plant. The small weight, used to hold the blanks during storage, will slide down a cartridge as blanks are removed but the spring and ball have a wedging action in one direction to keep weight from moving back up the cartridge.

quencies. Therefore, if a production plant's orders cover the whole frequency spectrum, no blank need be rejected. The x-ray sorter was thus designed to sort the crystal blanks into angular increments, preparatory to final processing. Blanks from the proper increment can then be selected for the fabrication of a group of crystals to a particular nominal frequency.

Input and Output of Machine

The crystal blanks, as they come to the sorter, are disc-shaped but with a flat necessary for proper orientation of the blank in this process as well as in subsequent processes, *Fig.* 3. They are of two diameters, 0.375 and 0.490-inch, and range in thickness from 0.020 to 0.035-inch. The sorter can be made to accommodate either diameter by a few simple changes in the mechanism.

The crystals arrive at the x-ray sorter in cartridges, *Fig.* 4, from the previous machine which has sorted the crystals according to thickness. The cartridges are designed to be used as crystal dispensers, collectors and storage devices at many stations throughout the plant. Each cartridge contains about 100 blanks, depending on thickness of the blanks.

The crystal blanks are measured, and sorted into cartridges identical in design to the input cartridges. There are 12 output slots, including one for rejects. Each slot can be adjusted to cover an angular range of from one minute to ten minutes of arc. The total range of the machine is 22 minutes. The normal production setup is to adjust each of the eleven active increments to cover 2 minutes of arc.

The precision of the machine, in exact terms, has been established as 10 seconds of arc, for one standard deviation. Put in a more descriptive way, the machine will sort 95 per cent of all blanks into the correct two-minute increment, the other five per cent being the borderline cases that will fall into either of the two adjacent bins.

Operator Functions

Start and Stop. *Start* and *Stop* buttons are the only operator controls on the panel of the machine (except for *Test*, as will be explained).

Load. The operator inserts a full cartridge into the input slot at the top of the sorter. The *Empty* indicator, which was on, then goes out. The machine removes the crystal blanks from the cartridge and sorts them, *Fig.* 5. When the cartridge is emptied, the *Empty* indicator is automatically lit, and the operator removes the empty cartridge and replaces it with another filled one. The *Empty* indicator then automatically goes out again, as described above.

Unload. The operator observes the blanks falling into the output cartridges. There is a row of lights over the output cartridges. When a crystal is sorted into one of the cartridges, the light cor-

responding to that cartridge will light. When the level in any cartridge reaches the *Full* mark, the operator presses a button corresponding to that cartridge, and the cartridge slides out of the machine. The operator than inserts an empty cartridge into the vacant output slot. She need not shut the sorter off for this operation, nor need she hurry, as any crystals which get sorted into that slot while there is no cartridge are collected and held until the new cartridge is inserted.

Test. At planned intervals or at the operator's discretion, the machine can be automatically tested by pressing the *Test* button. If the machine is operating properly, the small lights over the output cartridges will blink in sequence. If the lights do not signal proper operation, the operator must then request maintenance help. This test is simple, yet it checks almost the entire machine. It is believed that such test facilities on automatic equipment will assure less waste due to improper operation, and will reduce the burden on the plant's quality control system.

Machine Operation

The machine operation is based on a four-step cycle. Each step takes approximately 1.4 seconds, so a complete cycle for one crystal takes 5.6 seconds. However, a blank is being processed at each step of the cycle at all times; therefore, a measured blank is delivered to the classification chutes every 1.4 seconds. The cycle is as follows:

1. A blank is withdrawn from the input cartridge.

2. The blank is roughly oriented so that its flat will be in the down direction when moved to the next position.

3. The angle between that surface of the blank and the internal atomic structure is measured by means of x-ray diffraction.

4. The blank is discharged into the sorter, where it is sorted into the correct output cartridge according to the signal derived at Step 3.

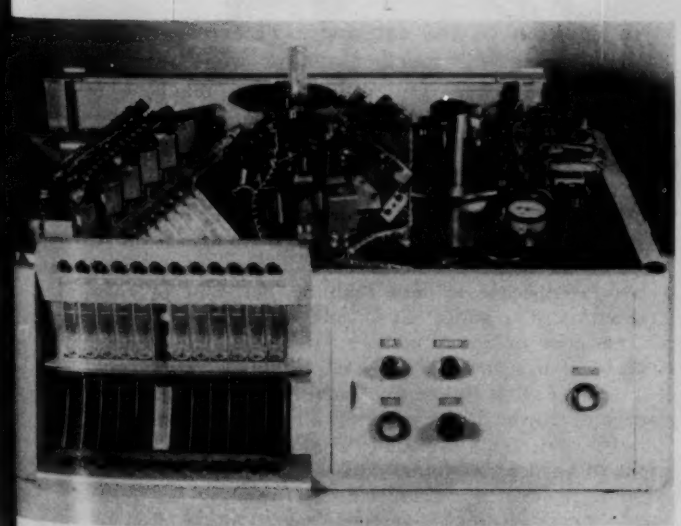


Fig. 5—Simplicity of operator's control is apparent. Input cartridge which feeds crystals to the machine is shown in center of machine at top. Output cartridges are arranged beside operator panel.

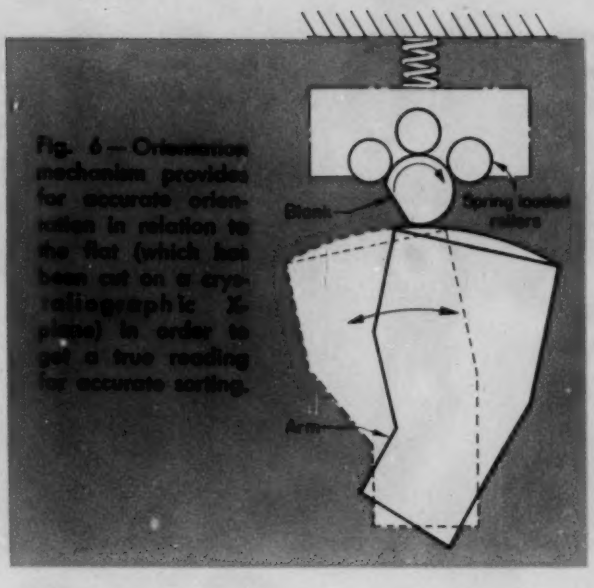


Fig. 6—Orientation mechanism provides for accurate orientation in relation to the flat (which has been cut on a crystallographic X-plane) in order to get a true reading for accurate sorting.

Vacuum chucks mounted in a Geneva-driven head hold and control the blanks throughout the cycle. These chucks are designed to swivel and rotate to allow for necessary motions of the crystal blank in the orient and measure positions.

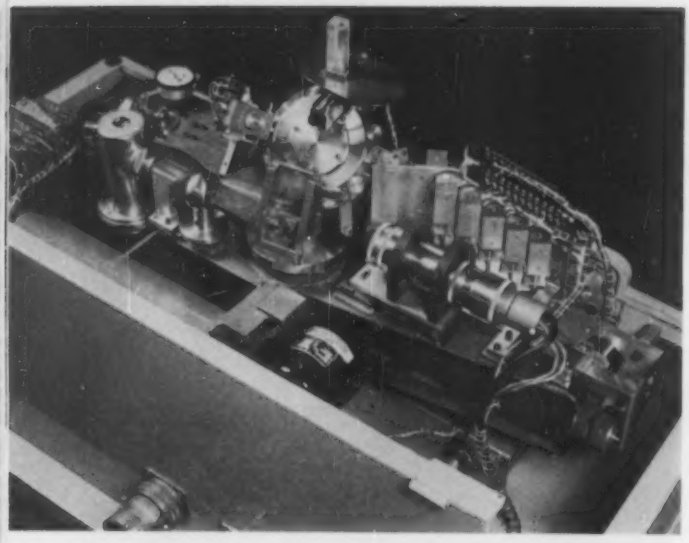
At the orient position, *Fig.* 6, the blank is rotated by an oscillating arm against three small rollers until its flat reaches the surface of the oscillating arm, after which time it slides. During this action, the vacuum chuck holds the crystal in position. The rollers are arranged so that the blank will continue to rotate until the flat reaches the oscillating arm, regardless of its initial orientation. The flat will never stay at one of the rollers.

At the measurement position, the x-ray sorter operates on a well-known principle of x-ray diffraction widely used in crystallography[1]. The x-ray beam is made to strike the face of the crystal blank, *Fig.* 7, and the blank is then rotated. At only one specific angle of incidence of the beam on the atomic plane in the crystal will there be a reflection, which reflection can be received in an x-ray detector. The angle which will give a reflection is known as the Bragg angle. As the face of the crystal is located against a reference surface, its position can be recorded electronically when the detector receives the signal. This establishes the angle between the face of the crystal and the atomic structure.

High Machine Speed

In ordinary industry practice, the measurement operation is commonly done by the rather slow expedient of peaking a signal output meter for maximum reflection, and then reading a vernier

[1]References are tabulated at end of article.



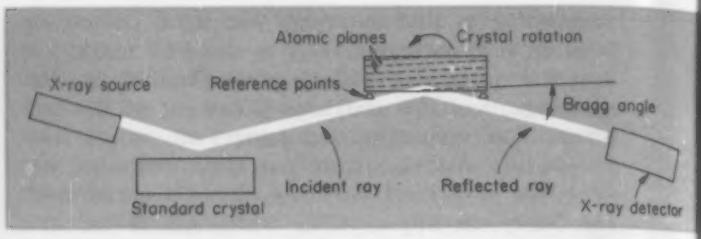


Fig. 7—Rear view of console shows x-ray tube and detector mechanism. The Geneva-driven head with vacuum chucks feeds the crystals through four steps in the cycle: Withdraw from input cartridge, rough orient, measure, and discharge at the sorter. The schematic representation of the physical arrangement of equipment shows how the x-ray sorter measures the angle between the atomic planes and the surface of a crystal blank. However, the outputs are defined with respect to the optic axis of the original crystal from which the blank was cut. Measurement is accurate to within 20 seconds of arc.

position indicator to establish the crystal angle. The automatic x-ray sorter, however, uses an instantaneous position reading system which operates while the crystal is in motion. A set of cam-driven limit switches produces a series of position signals during the sweep of the table on which the crystal rests during the measurement period.

These signals are used to produce a series of gates, *Fig.* 8, which open in sequence. The reflection signal from the crystal being measured is applied to all the gate channels, only one of which will be open at the time the reflection signal is received. The coincidence of the open gate signal and reflection signal is used to energize a relay, *Fig.* 9. Thus, the knowledge of the position of the crystal surface at the instant the atomic plane was at the Bragg angle is stored. This rapid method of measurement enables the entire measuring period of the machine cycle to be limited to 0.4 seconds, and accounts in great measure for the high production rate of the machine.

A factor which makes possible the use of the rapid measurement system just described is the use of a high intensity constant potential x-ray source, and an extremely fast response scintillation counter as the reflection detector. The constant potential x-ray generator was designed and built especially for use in the x-ray sorter by the Bracke-Seib X-Ray Company, Inc. of Pelham Manor, New York, and the scintillation detector was developed by the University of Oregon for the Signal Corps Engineering Laboratories under a separate contract. These devices provide a great number of pulses and a linear response during the very short time span of the received signal (50 milliseconds), which when integrated, produce the smooth, linear reflection signal necessary for readings of high accuracy.

▶ The Two-Crystal System

While the above devices allow high speed to be combined with accuracy, the high accuracy of the x-ray sorter is derived basically from the use of the so-called two-crystal system of x-ray goniometry[2], *Fig.* 7. This system is inherently 5 to 10 times as accurate as the single-crystal system, but it previously has only been a laboratory technique, and has seldom, to the author's knowledge, been incorporated into a production machine prior to its use in the Bulova x-ray sorter. The reader is directed to the references for the theory of this system, but it is sufficient to say here that the first crystal produces an extremely sharp, collimated beam, and directs it to the crystal being measured. This causes the reflection to the scintillation detector to be very sharp—about one minute of arc—and this results in the high accuracy of the unit.

▶ Designed for Reliability

In addition to the automatic *Test* feature previously described, much planning went into the unit to guarantee as trouble-free a machine as possible, and to make maintenance simple when it does become necessary:

1. All electronic components are used according to the following schedule, arrived at following work done under a U. S. Navy Bureau of Ships Contract[3] on reliability of electronic radar components: (1) Carbon resistors—operate at less than 50 per cent of rated dissipation; (2) paper capacitors—operate at less than 50 per cent of rated voltage; (3) mica capacitors—operate at less than 75 per cent of rated voltage and; (4) tubes—all voltages and currents less than 90 per cent and power dissipation of all elements less than 75 per cent. This schedule was designed for equipment to be used at temperatures up to 150 F. As the equipment in the racks will be running at about 90 F., this is an additional safety factor.

2. All tubes are heavy duty types, either GE 5 Star Tubes or RCA Red Base.

3. Where possible, only telephone type relays are used, and all relay contacts are conservatively rated.

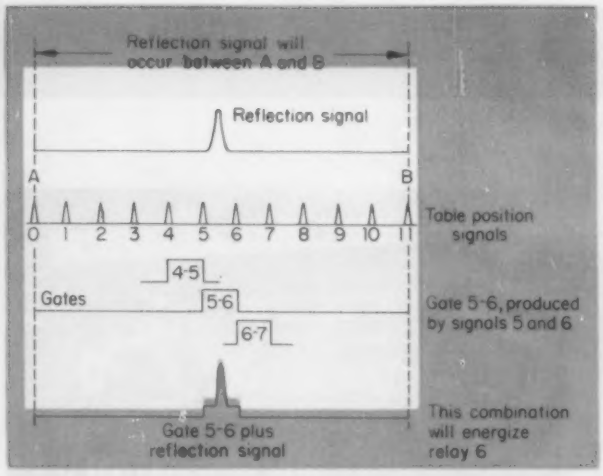


Fig. 8—Distance A-B represents the sweep of the oscillating table—about 22 minutes of arc and about 0.36 second of time. The positioning of the reflection signal between A and B indicates the angle to be measured. Coincidence system of gates and signal reflection measures and records the position of the signal.

4. In addition to many meters and fuzes, the following special interlocks and safety circuits are provided: (1) If the high-voltage cable connecting the x-ray power supply tank and the x-ray tube is disconnected from the tank, the hi-voltage supply shuts off; (2) the high-voltage rectifier filaments have indicator lights which show filament failure; (3) the x-ray tube has both over-current and over-voltage protection; (4) the high-voltage capacitor is automatically shorted when the equipment is turned off; (5) failure in the x-ray power supply equipment shuts off the sorter motor—this prevents incorrect sorting of crystals, and indicates to the operator that there is trouble in the equipment and; (6) a flow switch in the water-cooling line for the x-ray equipment will automatically shut the equipment off if water ceases to flow.

Summary

The crystal blank x-ray sorter is a completely automatic machine for measuring orientation of quartz crystal blanks, an essential step in the manufacture of frequency control crystal units. Though it utilizes generally known theories of x-ray diffraction, it has both greatly increased speed and accuracy compared with standard industry practices: operator skill and judgment have been virtually eliminated, as well as operator handling of the crystal blanks themselves. These advantages have been gained by an increase in machine first cost of approximately two-to-one, and by a substantial increase in complexity, which in turn is met by great attention to reliable design. As the machine has been designed for a specific use in a specific plant, it is not applicable to all types and shapes of crystal blanks, but the measurement and handling techniques are basic advances in the art and will probably establish themselves firmly wherever high production is required.

The x-ray sorter thus stands as an example of what the Signal Corps' Quartz Crystal Mechanization Program will accomplish, and it also represents in small part what a decisive and continuous application of engineering effort can accomplish in automation.

Special acknowledgment should be made to Messrs. Abe Mann and Georg Buergel of Bulova, who are chiefly responsible for the successful development of the X-Ray Sorter, and to Mr. Donald L. Hammond of the Frequency Control Branch, SCEL, for his advice and experimental work on the double-crystal system of goniometry.

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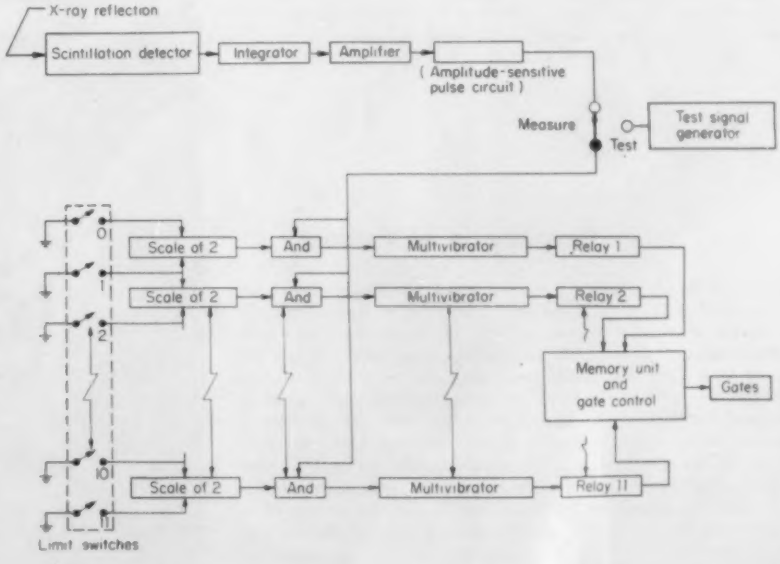
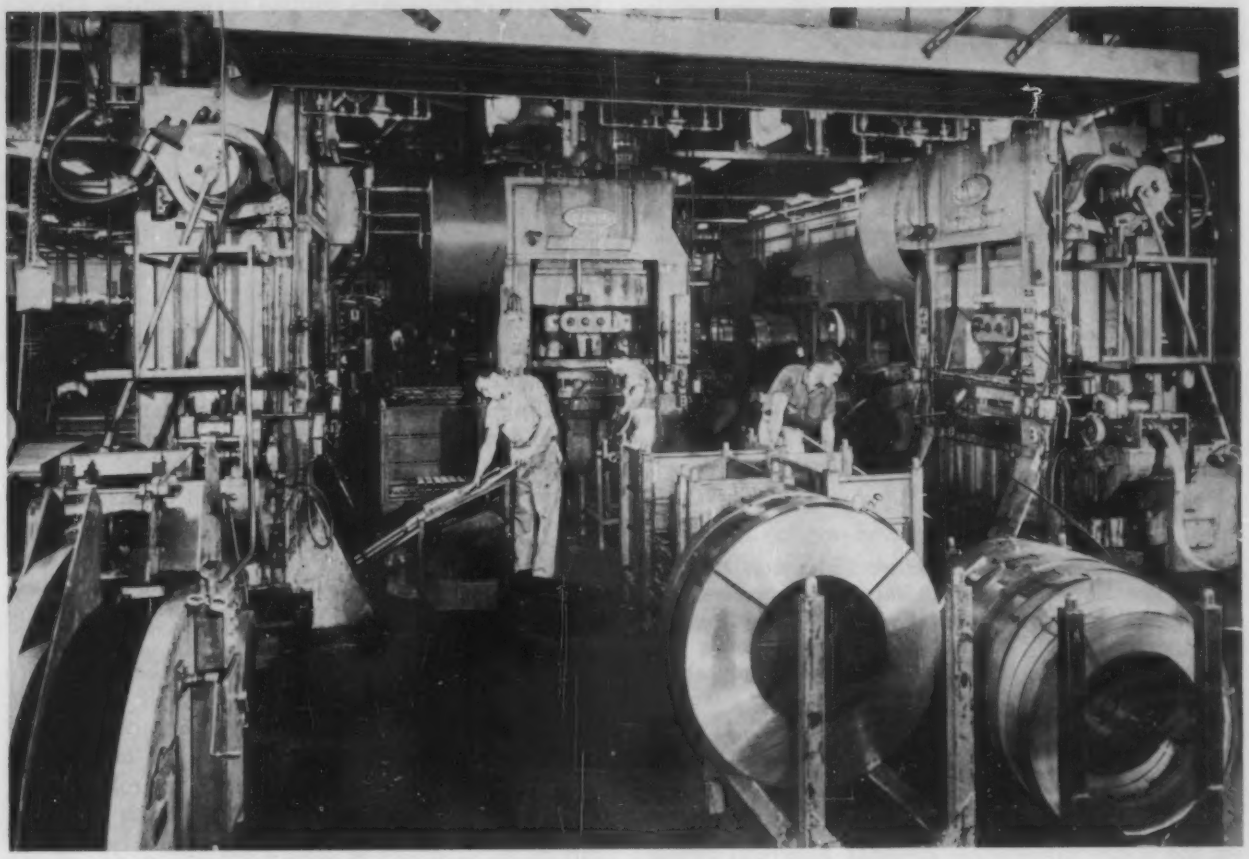
1. W. L. Bond and E. J. Armstrong, "Use of X-Rays for Determining the Orientation of Quartz Crystals", *B.S.T.J.*, Vol. 22, PP. 338-362, Oct. 1943.
2. W. L. Bond, "A Double Crystal X-Ray Goniometer", *Proc. I.R.E.*, Vol. 38, PP. 886-889, Aug. 1950.
3. *Electrical Engineering*, November 1955.

Fig. 9—Block diagram of main circuit components of x-ray sorter. The gates are produced by a series of limit switches operated in sequence as the oscillating table sweeps through the measurement cycle. The coincidence of the signal and gate in one *and* circuit will trigger the associated multivibrator and relay. The memory unit stores the signal for one machine step and then energizes the appropriate solenoid so that the crystal blank will slide into the correct cartridge. The signal delay is necessary since the previous crystal is being sorted while the present crystal is being measured.



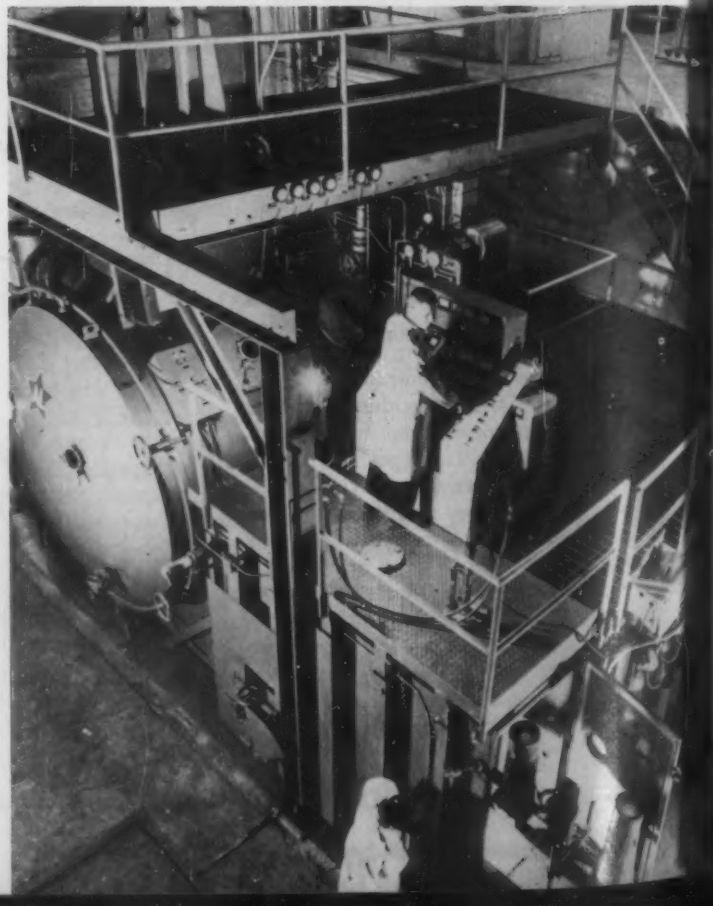


Lamination Production

APPLICATION of Danly Autofeed presses illustrates the gain made by updating plant equipment to take advantage of more advanced techniques. Previously, a manufacturer of fractional and small horsepower motors produced 100,000 laminations per three shifts. With new presses and carbide dies, production of 230,000 pieces per three shifts is obtained. Rigidity of press protects the progressive six-station dies; die life is one million pieces between grinding and 200 million pieces total life. Stock in coil form for automatic feeding is 2¾ and 3-1/16 inches wide by 0.057 inch hot-rolled silicon steel.

Handling in a Vacuum

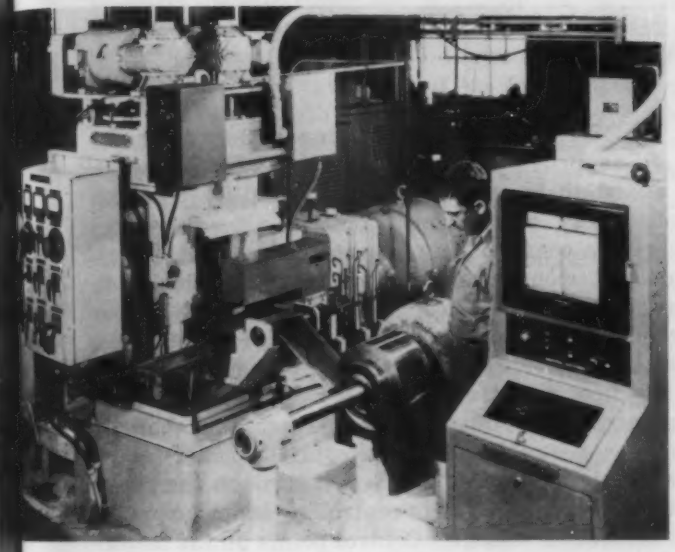
VACUUM MELTING furnace developed by F. J. Stokes Corp. for Allegheny Ludlum Steel Corp. includes a number of design features which permit continuous operations. Initially to be used as a unit of 300-lb capacity in research and development work, it will be converted to a 2000-lb capacity production unit as soon as studies are completed. Design permits charging the furnace, pouring ingots, and removal of the completed heat while the vacuum is maintained in the main melting chamber. Melting would have to stop only for crucible changes. The melting operation occurs under carefully controlled conditions of pressure and temperature. Reactions between gases and the melt are studied by means of a mass spectrometer which monitors the vacuum system. In the picture, hot ingots of vacuum melted and cast high temperature alloy steel emerge from the vacuum chamber below the central control point for the furnace.



in action

Warehouse Man Saver

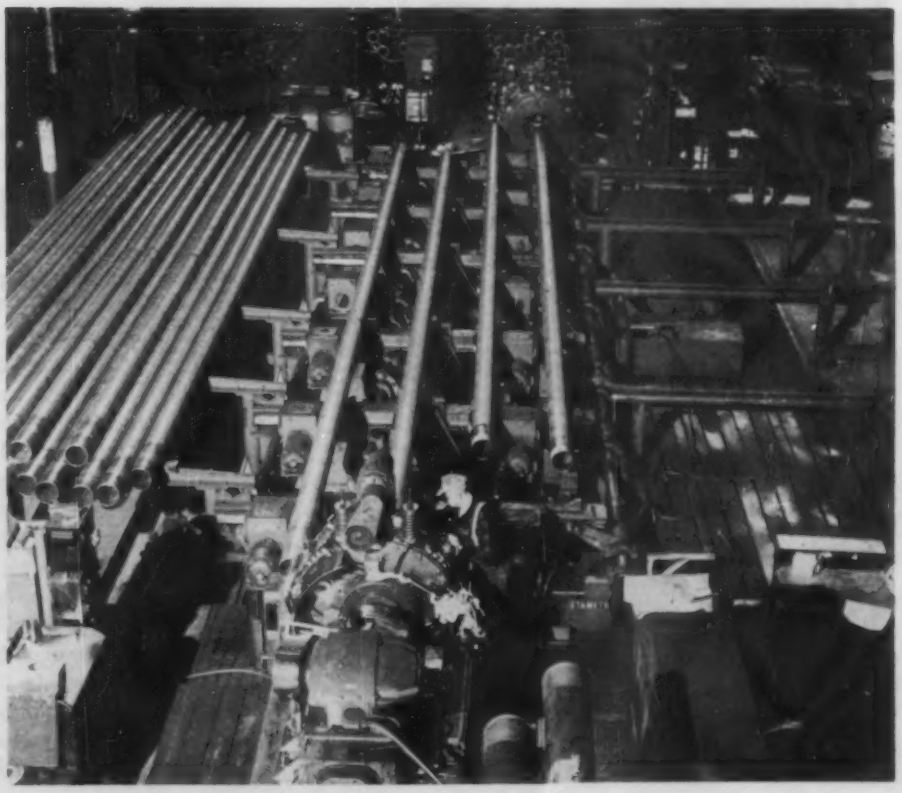
OPERATORLESS tractor is in regular service at a food warehouse of the Fleming Co., Wichita, Kans. Tractor can pull up to 6000 lb of freight along a path established by a guide wire embedded in the concrete floor. The wire marks a path from the truck loading docks to the grocery and produce sections of the warehouse. Use of the Barrett-Cravens Co. Guide-O-Matic tractor leaves manpower for other duties and eliminates the danger of a tractor running off course or being misoperated such as to damage merchandise.



Gaging Thin Strip

REQUIREMENT for more uniform metal strip tolerances by electronic and other industries has led Somers Brass Co., Waterbury, Conn., to turn to the electronics industry for aid. The company now checks and controls the thickness of thin strip metal during production by means of gages manufactured by Industrial Nucleonics Corp. As strip comes from the rolling mill every square inch is subjected to gage scrutiny and any deviations from specified tolerances (as little as ± 1 per cent of thickness) are automatically recorded as a guide for correction. In the event that greater than normal deviation occurs, the mill is stopped by the gage to eliminate overcompensation.

Threading Large Pipe



THREADING operations on oil well casing have been automated at the Spang-Chalfant Div. of the National Supply Co. Stamets threaders used in pairs at five different threading stations can be adjusted to different sizes of pipe. Additional equipment at each location includes a handling table which has positions for four pipes, two from each threader. The paired threaders operate simultaneously on two lengths of pipe. As a single pipe is finished, system provides for automatic shifting of five lengths of pipe. Single operator inspects finished threads and makes adjustments to machinery or tooling as required.

USE METER-RELAYS

TO MONITOR AND CONTROL

By PAUL SAINT-AMOUR
Assembly Products, Inc.
Chesterland, Ohio

Fig. 1—Meter-relays including types with either high or low control points, or both, as indicated by the dials and the adjustable pointers. In any event, the indicating pointer (moving with the signal) cannot move past the adjustable pointer (which indicates the preset limit of current or voltage). Full scale movement is usually in excess of 95 angular degrees.

METER-RELAYS are being used increasingly as primary automation components because of their reliability and versatility and because they can perform functions formerly requiring a combination of several instruments. They indicate, monitor and control any condition that can be measured electrically through a suitable transducer. Like all relays, they are essentially amplifying devices, but they go a step farther. They first detect and indicate very small changes in current or voltage. Then, when the changes reach a preset limit, contacts in the meter-relays lock and useful work is effected through the opening or closing of circuits controlling larger amounts of current or voltage. Control points on the meter-relays may be adjusted simply and easily over a wide range.

Contact meter-relays are basically combinations of locking relays and permanent magnet, moving coil meters (D'Arsonval) with certain other equipment added. Hence meter-relays can be produced in any of the ranges of standard D'Arsonval meters—any measurements that can be detected and noted on D'Arsonval meters can be the basis for control with meter-relays. In simplest applications, they are used to actuate an alarm or to turn auxiliary equipment *Off* or *On* if a change in signal occurs. The contacts remain closed until manually reset. In more complicated applications, they are used to maintain a process at a given level by on-off control using associated circuitry for periodic automatic testing of the process being controlled. Meter-relays can operate directly from strain gages, differential transformers, thermocouples, Wheatstone bridges, tachometer generators, thermistors, photocells, etc. TABLE 1 outlines typical control problems and the appropriate meter-relay circuits for accomplishing the control desired. A number of contact meter-relays, some actuated by current, others by voltage are shown in *Fig.* 1.

Ranges of current-actuated meter-relays are from zero to 5 microamperes, to zero to 50 amperes. Both dc and ac models are available. Voltage-

If a variable can be measured by a D'Arsonval type meter, it can be controlled by meter-relays. The broad field of application for these relays is an indicator of the industrial sweep of the field of automation. The only term expressive of this utility in all industry is "automation component."

sensitive meter-relays are available in dc with instruments of zero to five millivolts full scale deflection and extending to instruments of zero to 500 volts. Ac units are not available in the low millivolt range, with the practical limit being zero to 250 millivolts, the upper limit zero to 500 volts.

Known applications for meter-relays are almost of infinite variety, and are increasing daily. Perhaps the greatest factor in this popularity is the adaptability of meter-relays to a large number of functions. They are widely used as control units in machinery and equipment built for specific purposes by the equipment user and as the basic components of elaborate instruments made by control equipment manufacturers. Before describing several typical applications, however, it may be helpful to discuss the details of meter-relays and how and why they function as they do.

How Meter-Relays Work

In D'Arsonval meters, current is passed through a coil suspended on jewel-pivots in the field of a permanent magnet. Restrained by some force, usually hairsprings, the coil moves to various positions in proportion to the amount of current passed through it. These positions are indicated on the face of the meter by a pointer carried by the coil. Meters of different sensitivities are produced by varying the strength of the magnet, the number of turns of wire, the shape of the magnet poles surrounding the coil, and the strength of the hairsprings which restore the coil to a zero position when the current is removed.

The meter-relays idea was suggested by the thought of putting a contact on the pointer carried by the moving coil and putting another contact somewhere inside the meter. The contacts were so placed that when the signal current rose or fell to a certain point, the contacts would close or open to control slave relays. This arrangement was obviously superior to watching a meter and pushing a button when the pointer indicated that such action was necessary.

Unfortunately, this idea proved more difficult to implement than to originate. A typical microammeter can exert only a few milligrams pressure at the point of contact, and contact so made is usually unreliable. Moreover, such contacts have exhibited a tendency (because of slight arcing, mechanical wear and natural adhesion) to stick together instead of separating when the signal is moved. These failures may not be evidenced immediately, however.

To provide reliable contact pressure, meter-relays made by Assembly Products have an extra coil, usually consisting of about 100 turns of No. 46 wire, wound on the same form as the normal signal coil. As shown in the basic meter-relay circuit in *Fig.* 2, this extra coil is connected to the contact carried on the moving pointer and to a dc (or rectified ac) source in series with the load—usually a relay or light. When the contacts come together—even very hesitantly at high resistance—there is enough current flow through this locking coil as the circuit is closed to produce a further

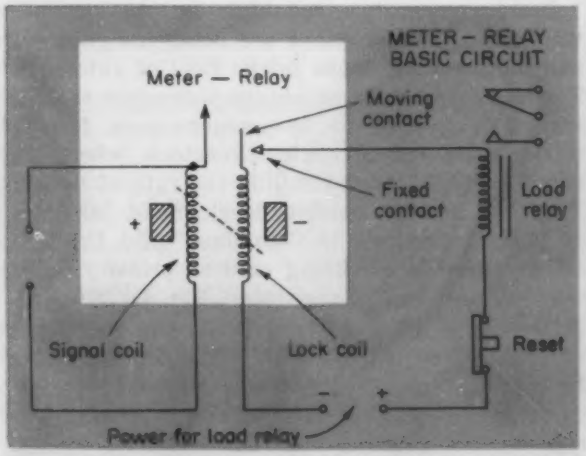


Fig. 2—Basic meter-relay circuit showing the extra coil used to provide more reliable contact pressure. This coil provides additional D'Arsonval effect and builds up contact pressure until full current flows through the contact so made.

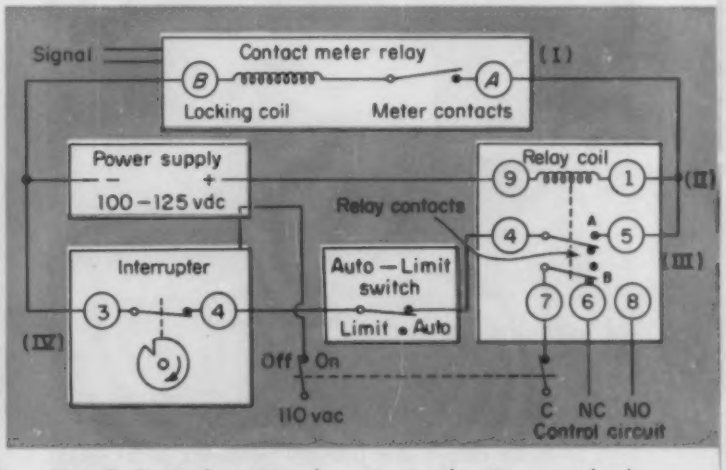


Fig. 3—Typical meter-relay circuit showing standard-limit automatic reset with interrupter. This arrangement is used to provide on-off control since meter-relays in themselves do not "break" contact when the signal departs from the "make" point.

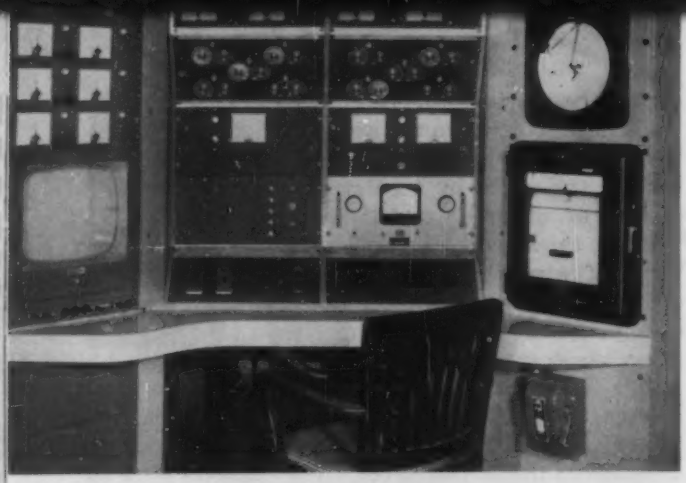


Fig. 4—Three sets of meter-relays are used as primary components of the control apparatus of the nuclear reactor development laboratory of Battelle Institute. The panel provides all the controls that would be found in a full scale atomic power plant. Meter-relays monitor and control the gamma radiation level, rate of neutron production and the reactor period.

D'Arsonval effect. This adds torque to the movement of the coil and builds up contact pressure until full current flows, locking the contacts securely together. Without this extra torque, the contact pressure of 10 per cent overdrive (signal past contact point) in a meter-relay with a range of zero to 100 microamperes will be about 5 milligrams. The locking coil torque increases the pressure to 1 to 3 grams—with no overdrive. The additional torque also loads the spring on which the adjustable contact is mounted. When the current flow through the locking coils is interrupted, the loaded spring kicks the contacts apart with a positive action that prevents sticking.

It should be noted that meter-relays do not "drop out" as do conventional relays when current through the signal coil is reduced. To get on-off action, a sampling circuit with an automatic interrupter is generally used. The meter contacts are unlocked periodically to sample the signal current. If the signal is still at the control point, the meter contacts again close and lock quickly. The load relay is delayed so that it does not drop out during this brief interruption cycle. If the signal has changed sufficiently, however, the meter contacts remain separated and the load relay releases. A typical meter-relay circuit of this type is shown in *Fig.* 3.

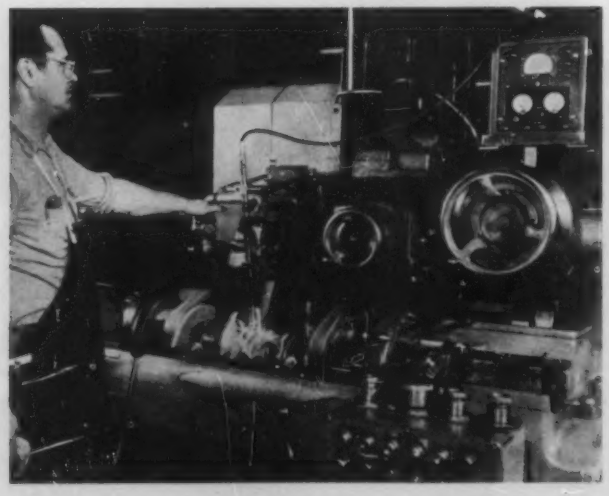


Fig. 5—Meter-relays are primary elements in an electronic grinding control unit made by Airborne Instruments Laboratory. Measurements of the workpiece diameter are transduced to voltages which become signal input to the meter-relays, visible in the control unit, upper right.

Accuracy and Response Time

Actual operating accuracy of meter-relays is usually greater than that of dial indications, although both conditions can be improved through special features. In all circumstances, point of contact accuracy—the differential between the signal that will leave the contacts open and the signal that will close them—is less than 1 per cent of the full scale of the dial. Dial indicating accuracy of most meter-relays is plus or minus 2 per cent of full scale. Therefore, with full scale reading of 10 microamperes and point of contact accuracy of 1 per cent, a change of 0.1-microamperes will actuate the contacts. With a zero to 5-millivolt scale, the differential can be as small as 1/20 of a millivolt.

Normal response time of a contact meter-relay to an applied signal can range from 100 milliseconds to 10 seconds. Response time is the interval from the moment the signal current (or voltage) reaches the meter coil and the moment the coil and pointer arrive at a position proportionate to the signal. With overdriving (applying more current than necessary to reach the contact point) response time may be cut to about 10 milliseconds.

Typical Applications

Besides versatility, reliability is a major reason why contact meter-relays are being assigned more and more critical tasks in the field of automation. Testimonial to their reliability is the fact that it is standard practice to use meter-relays for protective purposes in nuclear reactors, where they actuate equipment controlling the rate of reaction.

In the nuclear reactor development laboratory of Battelle Institute in Columbus, Ohio, three sets of meter-relays are being used as primary components of the control apparatus, *Fig.* 4. The panel, designed and built by Battelle engineers, provides all the controls that would be found in a full-scale atomic power plant, since the purpose of the laboratory is to develop new types of nuclear reactors for power production. The meter-relays operate in response to currents that are functions of the amount of nuclear fission occurring in the critical assemblies being studied.

Three meter-relays are used as primary elements in an electronic grinding control unit made

TABLE I—How to Pick the Correct Meter-Relay

Typical Control Problems	Appropriate Meter-Relay Circuit
Control of variable at a given level (on-off control).	High limit automatic reset (frequency of interruption can be from four per second to one per hour).
Shutdown and lock when increasing signal reaches a predetermined point.	High limit manual reset.
Shutdown and lock when decreasing signal reaches a predetermined point.	Low limit manual reset.
Shutdown and lock if signal varies from normal, high or low.	Double contact manual reset.
Pulsing control (light, buzzer, corrective action, etc.) when signal reaches a point.	Self-releasing circuit (high, low, or double contact). Control action ceases when signal is restored to proper level.
Actuate control device if signal drops to low point, or actuate another device if signal rises to high point. No control action if indicating pointer is between preset contact points.	Double contact automatic reset (three-band control).
Actuate control device if signal drops to low point. Keep *On* until signal reaches high point (controlled differential). Turn *Off* at high point. Turn on again when signal drops to low point. (This whole process can be reversed, starting with control action at high point, etc.)	Interlocked or cycling.

by Airborne Instruments Laboratory, *Fig.* 5. This control enables automatic grinders to remove more than .075-inch of stock from an automotive crankpin in about 45 seconds—with size accuracy held to ±0.0001-inch. Measurements of the workpiece diameter are translated into voltage by a transformer contained within the gaging rod, and this voltage is converted within an electronic unit to actuate the meter-relays. When the preset work diameter controlled by each meter-relay is reached, contacts lock and actuate power relays. In turn, the power relays operate appropriate solenoid valves on the grinder, and the solenoids control such grinder functions as rate of wheel feed and wheel withdrawal at final size.

The controller in *Fig.* 6 is an example of a self-contained package unit incorporating a meter-relay with a circuit designated as high limit, manual reset. Furnished by the Tipp Manufacturing Co., the controller may be used for a variety of purposes, but in the picture shown, it is used to prevent damage to the conveyor or motors from overload. When the load on the motors reaches a predetermined level as measured by the adjustable pointer on the meter, the conveyor system is automatically shut off. It must be manually reset. A time delay permits an initial surge to start the motor again.

One of the most interesting applications of contact meter-relays is another controller, made by the Archer-Reed Co., which monitors the irradiation of blood plasma by ultraviolet rays in the high intensity germicidal wave band, *Fig.* 7. It is believed that sterilization of almost the entire United States supply of plasma is monitored by units of this type.

Ultraviolet energy impinging on a photocell causes a signal to be generated, in terms of milliwatts per square centimeter of ultraviolet intensity. The signal is picked up and amplified by an electrometer and transmitted by cable to the controller. The meter-relay in the controller is calibrated from zero to 20 microamperes. One pointer on the meter-relay is manually set to indicate the lowest satisfactory limit of ultraviolet intensity, while the other pointer indicates actual intensity and fluctuates with its variations.

If for any reason the intensity drops to the low limit, the meter-relay contacts lock, the controller flashes a red light, and electrically actuated hose-cocks on the input and output fluid lines connected with the irradiator are clamped and locked closed. Thus plasma that has not been properly irradiated is isolated. Flow cannot be resumed until the conditions causing low output of ultraviolet have

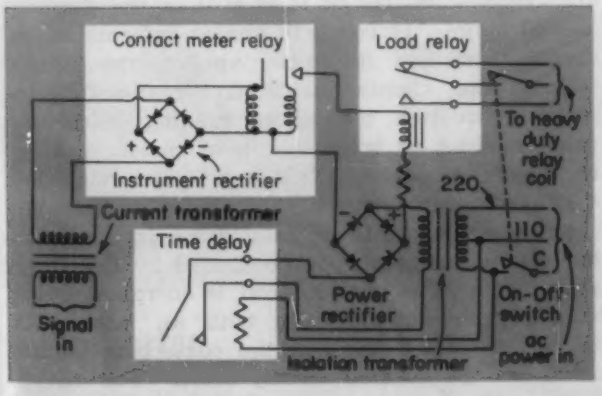


Fig. 6—Installation showing meter-relay application used to prevent overload damage to conveyor system. Circuit diagram illustrates the meter-relay function in the overall control system.

Fig. 7—Use of contact meter-relay in control units of systems for irradiation of blood plasma at Merck Sharp and Dohme Div. of Merck and Co. Plasma is being irradiated inside the large cylindrical tubes. Intensity of ultraviolet light used for irradiation is measured by a photocell which in turn supplies the input signal to the meter relay.

been corrected. Even then, all hosecocks must be reset manually. Essentially, the same thing takes place if there is a power failure or a power disturbance sufficient to produce a detrimental change in the sterilizing process. A strip tape recorder makes a permanent record of the fluctuations in ultraviolet intensity.

Meter-relays are important elements in the magnetic testing machine shown in *Fig.* 8, recently installed at the permanent magnet plant of the Metallurgical Products Department of the General Electric Co., (see AUTOMATION, Feb. 1956, Pg. 44). The unit processes about 1600 speaker magnets per hour. From a rotating hopper, magnets roll down a tiny gravity conveyor to a feed wheel which carries them to the testing side of the magnetizing fixture. The magnet under test is placed in one side of a soft iron test yoke and magnetized in place. The magnetomotive force appearing across the poles of a generator is a measure of the quality difference between magnets. Since the armature is driven at constant speed, the generated voltage applied to the indicating coil of the meter-relay is also a measure of quality difference. Magnets which are stronger than the standard by a predetermined amount, as set on the meter-relay, cause the indicating pointer to lock with the *High* pointer and to energize such auxiliary equipment as signal lamps, counters and trap doors. Similarly, weaker magnets cause the *Low* meter-relay contact to be engaged. Magnets which do not cause the signal to reach either the high or low points are automatically classified as good.

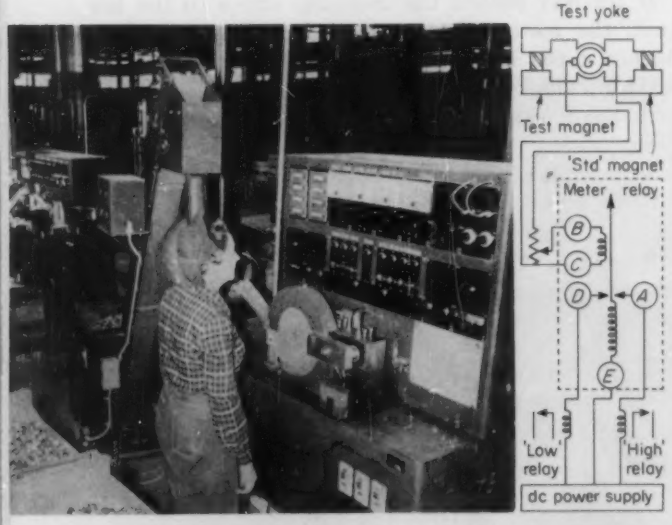


Fig. 8—Magnetic testing machine which processes about 1600 speaker magnets per hour. Both the magnet to be tested and a standard magnet are magnetized, then compared. Production magnets are segregated into quality classifications by equipment actuated by meter-relays. Schematic diagram indicates the function of the meter relay in the measuring circuit.

Among other applications for meter-relays are: Automatic radar systems such as the Distant Early Warning screen—DEW Line—across North America; automatic gaging and sorting of parts according to size, smoothness or other characteristics; monitoring temperatures of bearings in petroleum pumping stations, causing pumps and motors to shut down and oil to be rerouted to standby lines when a bearing gets too hot; pH control in automatic titration; automatic switching of standby microwave equipment; control of speed, pressure, deflection, torque, timing, heat, sound and light in a variety of industries; control of bulk material flow and chemical processes; and automatic high speed checking of the various electrical properties of vacuum tubes.

New Developments

Along with new applications, new types of meter-relays are being developed. Most prominent of these are the very high sensitivity relay and the multiple contact meter-relay.

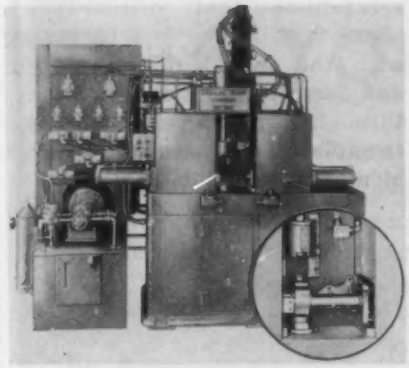
The very high sensitivity relay operates like a conventional meter-relay but it has no dial or pointers. The voltage or current setting at which the contacts lock is usually fixed at the factory. Sensitivity ranges from 0.2 microamperes to 10 amperes, or from 0.1 millivolts to 500 volts.

Prototypes of the multiple contact meter-relay are available, although it is still in the developmental stage. It converts analog information to digital form and its initial applications include telemetering, simple quantitative read-out, automatic production testing or grading, maximum value reading or transmission of meter readings to remote locations. This new meter-relay has a D'Arsonval meter movement but a printed circuit scale replaces the normal dial. In operation, the contacting pointer is positioned by the D'Arsonval coil. The read-out coil is energized either manually or automatically with an interrupter to pull a pusher bar and the contacting pointer down on the printed circuit scale. The output is a unique combination of closures dependent upon pointer position. These new developments will undoubtedly expand the already extensive utility of this type of automation component.

AUTOMATION new equipment

Machines and plant equipment designed for more automatic operations

For detailed information and literature, use card page 17



Automatic Assembler

Five operations are performed on steering gear housings in a 10-second cycle by automatic assembly machine. The cycle is: (1) Hopper feed and press in place one welch plug. (2) Hopper feed and press in place two bushings. (3) Press in place one ball race. (4) Burnish ID of two bushings. (5) Inspect ID of two bushings. Inset in illustration shows the parts in place for the operations. **Cadillac Stamp Co., Machine Tool Div.**, 17315 Ryan Rd., Detroit 12, Mich.

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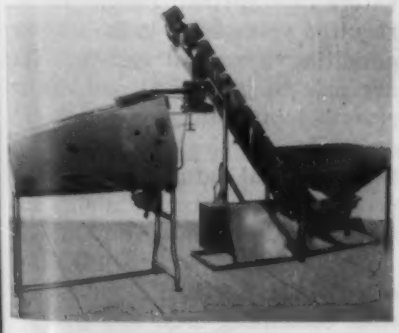

Precision Sorter

Used to gage or sort a variety of items such as relay contacts, beads, throat lozenges, steel balls, rubber washers, small die cast parts, buttons, etc., precision sorter gages parts at speeds up to 200,000 parts per hour with a maximum error of ±0.0003-inch. Unit will sort parts such as washers, nuts, and disk shaped objects for thickness only. It will sort cylindrical parts for diameter; and screws, rivets, and other headed items for head diameter only.

Sorter consists basically of two hard chromium plated rollers, precision ground for concentricity and straightness. Rollers are inclined at an angle and revolve so that their adjacent sides move upward. This action of the rollers causes the parts deposited between them to move along in the channel formed between the two rollers. Both ends of each roller are individually adjustable so that any opening and any gradation of the space between rollers is possible within the range of the machine.

As the parts move along between the rollers, they fall through and into the proper receptacle, when the diameter or thickness of the parts corresponds to the space between the rollers. In the illustrated model the parts to be sorted are dumped into the hopper of the Lift-O-Matic which has a capacity of 6 cu ft. A vibratory unit feeds the parts at any desired rate into the buckets of the elevator. **U.S. Engineering Co.**, 40-24 22nd St., Long Island City 1, N.Y.

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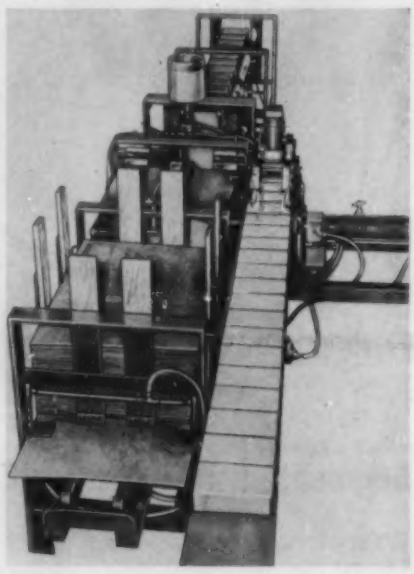
Case Opener & Former

Designed to automatically open and form corrugated cases, accumulate the contents, inject them into the case, glue and seal so as to be ready for shipment or warehousing, Quadnumatic packs such items as canned milk, household wax paper, spark plugs, oil filters, flash bulbs, etc.



In operation, cases are selected automatically from a stack at the end of the machine, carried forward one at a time, and brought into the opened and formed position adjacent to the accumulator magazine. When the required number of packages, cans, slabs, catalogs, etc., are accumulated, the machine automatically trips and the plunger inserts the load into the opened case. This action automatically starts the filled case forward, carries it through the gluing and folding arms into a pressure sealing unit. Simultaneously, another case is brought into the opened and formed position, completing the cycle. Machine is pneumatically operated.

Quadnumatic is constructed of welded steel and occupies a space approximately 16 ft in length and 30 inches in width, depending on the case size, with a projection to the side for the accumulator section, measuring approximately 15 by 40 inches. **Schroeder Machines Corp.**, P.O. Box 1123, Syracuse 1, N. Y.

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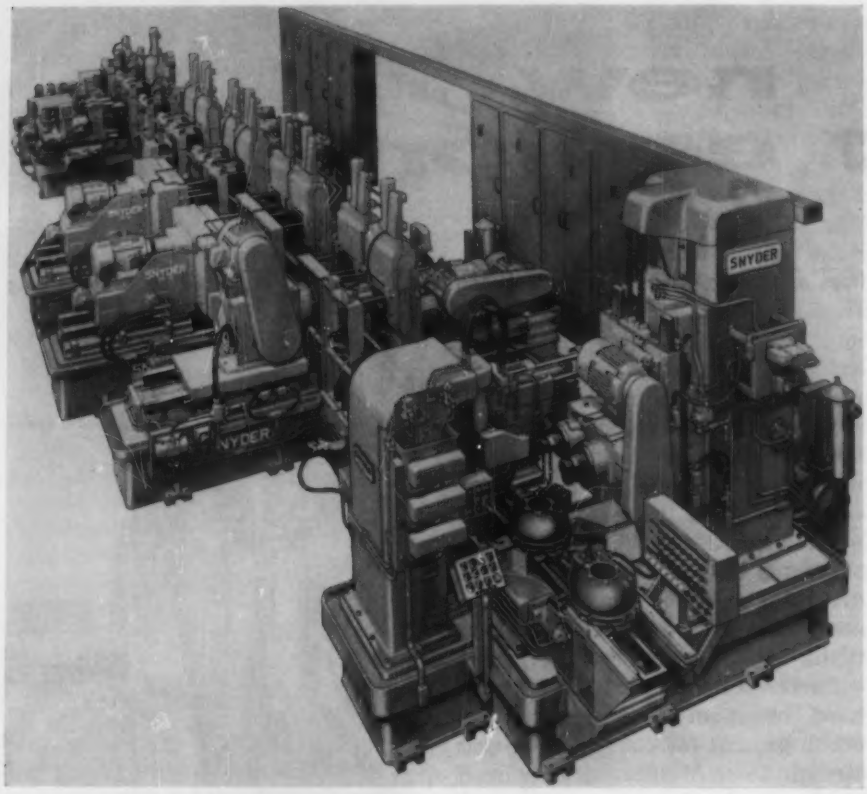

Segmented Machine for Converter Housings

Target milling operation which avoids the necessity for a pallet type mechanism has been included in 24-station, 55-ft long, segmented in-line transfer machine. Elimination of the pallets means less machine floor space requirements, no chip cleanoff operations, no pallet maintenance and no distortion problems due to the release of clamping forces.

The hydraulically operated, electrically controlled machine which processes 128 converter housings per hour has an automatic device which tips the part up after the target milling operation. It also includes an integral four-spindle precision boring operation, automatic precision air gage inspection and automatic probing of all tapped holes before tapping to assure correct drilling depth. Machine is made up of nine individual segments, each having its own electrical control panels and individual base.

Milling of three pads on the side of the cast iron part, while locating from critical clearance surfaces on the inside of the part, enables the part to be tipped up and located on the pads throughout the transfer on rails from one machining operation to the other. **Snyder Tool & Engineering Co.**, 3400 E. Lafayette, Detroit 7, Mich.

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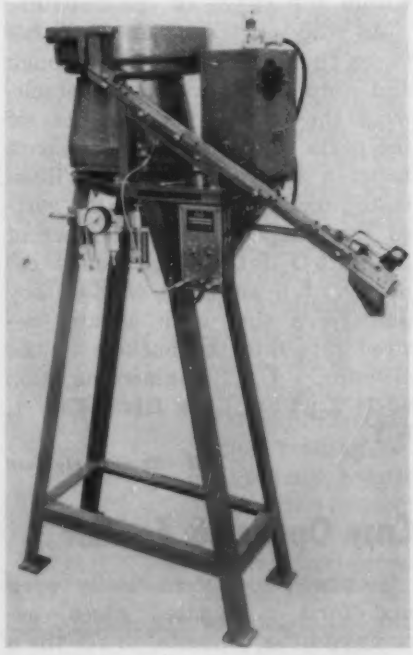

Thread Roller Feeder

Used to handle eye bolts, set screws, thumb screws, hook bolts, studs, pins, and other headless or nonsymmetrical headed parts, line of automatic thread roller feeders is tooled to handle five different eye bolt sizes on the same track. Parts from ½-inch OD of the eye by 1-inch overall length through 1-inch eye OD by 3 inches overall length can be fed. Machine can be modified to handle an overall length of 6 inches.

Unit uses a vibratory feeder. Parts go down a track to an escapement that orients them shank first. Feeder is synchronized with the thread rolling machine and operates in its speed range up through 75 pieces per minute. **Automation Development Corp.**, 38845 Mentor Ave., Willoughby, O.

Circle 405 on Reply Card

Numerical Data Printers

Used in automation and data processing systems, numerical data printers are available in both serial and parallel entry types. Machines, providing permanent printed records, are available in capacities from 8 to 11 digits. They are capable of taking input in various forms, manual or remote, and delivering it in equally diverse forms.

Machines may be operated from externally applied pulses of the required voltages to make an entry or initiate a control system. They are able to print, add and convert remote input into perforated tape or cards. Typical applications of the numerical data printers include problems of digital voltmeter and shaft position conversion.

The ten-key serial entry machines may be used in connection with tabulating card key punches, Addressograph plate punches, typewriters, punched tape readers, laboratory and industrial testing equipment and other data handling work. The full keyboard parallel entry models can be used for printing or printing and accumulating

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Computers

High speed computers are only as accurate as their voltage supply is correct and stable. Instant compensation for fluctuating voltage is provided by G-E voltage stabilizing transformers. The transformers keep voltage stable ***every cycle*** the equipment is operating—prevent relays from dropping out.

Electronic Induction Heaters

Costly maintenance problems are reduced on electronic induction heater applications with G-E voltage stabilizing transformers. Stable voltage permits maximum tube life—assures continuous high-quality production in metal-working plants.

Sequential Relaying

In today's automatic production cycles where each operation is interdependent on another operation, a single component failure because of voltage fluctuation puts the entire line down—production dollars, man hours, are *lost*. G-E voltage stabilizing transformers pay for themselves the first time they prevent a line stoppage due to voltage fluctuation.

Metering and Testing

Your production line power supply can be used for metering and testing if you stabilize voltage at the application. G-E voltage stabilizing transformers installed at the load will stabilize voltage to plus or minus 1% within 1½ cycles. Gives you laboratory test voltages right on the production floor.

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information from computers, oscillogram and graph readers, analog to digital converters and other data reduction devices. **Electronics Div., Clary Corp.,** San Gabriel, Calif.

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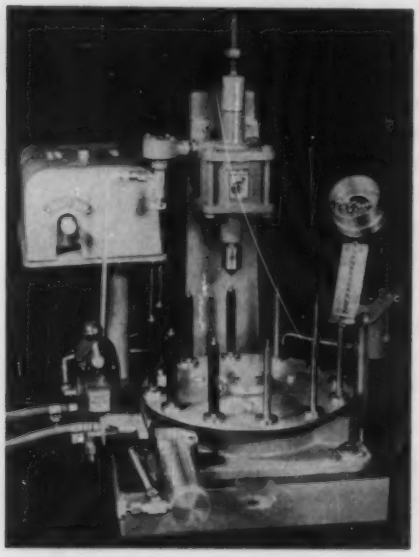
Processing Pen Barrels

An air-operated rotary work feeder combines with a pneumatic timer, an air press and a miniature hopper to crimp eyelets and rings on the barrels of fountain pens. All units are mounted on a standard universal base to form a semi-automatic operation; the operator keeps the hopper and dial loaded.

The pen barrels are held on 12 special studs around the rim of the dial, where they are placed by hand over the eyelet which has dropped on the stud from the hopper. At the workstation a single-acting air cylinder with crimping tool attached to the ram presses the components together. The cylinder has



an upper ram with threads and lock nut to stop the down stroke at the right point. The Meadmatic timer, a self-contained unit mounted on a post, controls the number of cycles per minute and the length of the dwell. A quick exhaust valve at the cylinder air intake hastens the return stroke to clear the work before the table indexes. A speed control valve regulates the down stroke of the tool. A midget air cylinder, also deriving its air from the timer, rotates the hopper. **Mead Specialties Co.,** Dept. RW-46, 4114 N. Knox Ave., Chicago 41, Ill.

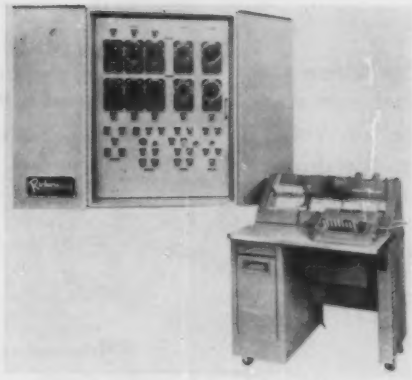
Circle 407 on Reply Card

Rotary Indexer for Compressor Crankcases

More than 20 operations are performed by eight-station rotary indexing machine which processes air conditioner compressor crankcases. Operations include rough boring, counterboring, facing, spot facing, drilling, chamfering, back chamfering and tapping. Machining cycle is entirely automatic, including clamping and unclamping.

Made of die cast aluminum with cast iron cylinder liners, the crankcases are of three different types — one, two and three-cylinder. Changeover from one model to another can be made frequently with automatic rotary machines. An average net production rate of 87 pieces per hour is normally maintained. **Ex-Cell-O Corp.,** 1200 Oakman Blvd., Detroit 32, Mich.

Circle 408 on Reply Card



Proportioning Panel

Used in grain and feed plants, rock product installations, and chemical processing operations, fully automatic, electronically controlled proportioning system records formulas and weighings on a summary punch card by means of a recording device interlocked with the action of the panel. Information is transmitted from the Select-O-Weigh automatic proportioning system by means of equipment which digitizes individual weighing and sends the information to an IBM Type 526 summary punch. This feature permits users to process billings, maintain inventory control and keep similar records of weighing and proportioning by processing punched cards through an IBM business machine.

Illustrated system controls three scales, with three weight selectors for the first scale, and one each

for the second and third. Each of these units can be selected *In* or *Out*. A second group of selectors is also supplied on the panel, so that two formulas can be simultaneously set up and run through the proportioning system. System is designed for fully or semiautomatic operation. Under fully automatic operation, a formula is set up on the panel's control dials; the system can then be set to repeat the formula automatically as many times as desired. **Richardson Scale Co.**, Van Houten Ave., Clifton, N. J.

Circle 409 on Reply Card

Index Type Deburring

Continuous deburring of finish machined cast iron or nonferrous parts at rates ranging from 250 to 350 per hour can be attained with index-type Burr-Blasters which are designed for in-line installations. Machine is used for removal of fragmentary burrs—all those not caused by upsetting of metal.

Parts enter at the front of the machine and either roll or slide down a track to the loading station where they are clamped automatically by a neoprene mandrel mounted on an air cylinder. The work holding fixture is indexed, elevating the workpiece into the blasting cabinet. To insure thorough and uniform removal of all fragmentary burrs, the part is rotated continuously during the blasting operation. Ground up walnut shells and peach pits, silicon carbide, aluminum oxide, steel shot

ARTER JIGMATIC WILL DO *all* YOUR POSITIONING AND *do it fast*

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TAPE-CONTROLLED AUTOMATIC POSITIONING TABLE

Check These Features...

- No stops
- No gauge rods
- Only SECONDS to change tapes
- MINUTES to set up
- No more than 11 tape holes to punch per position
- 600,000,000 possible positions. Hundreds of positions per single set-up
- Automatic magnetic locking
- Accuracy — plus or minus .001"
- Unidirectional approach at minimum speed
- Simultaneous operation of both coordinates

The 20"x30" ARTER has them all

ARTER GRINDING MACHINE COMPANY

WORCESTER 5, MASSACHUSETTS

Jigmatic Automatic Tape Controlled Positioning Table • Rotary Surface Grinders
Flat Circular Cutter Grinders • Internal Grinders • Cylindrical Grinders • Carbide Tool Grinders

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Automation is the key to greater production of more goods and services at lower cost. The Tools of Automation can be applied profitably in a countless number of individual industries.

Reliance can provide *you* with valuable engineering assistance which can help secure the advantages of automation.

Our Tools of Automation consist of electric motors, variable-speed drives and controls.

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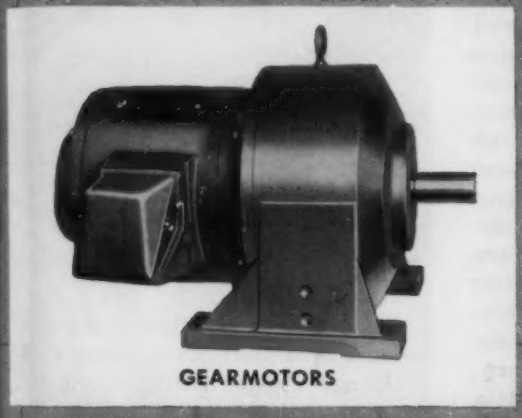
TOTALLY-PROTECTED MOTORS

REEVES MOTODRIVE



GEARMOTORS

RELIANCE MOTORS ON HIGH SPEED AUTOMATIC TRANSFER MACHINES

AUTOMATION

Application of these tools ranges from a single motor to multi-motor drives for highly complex production lines, where materials are processed into finished products in one continuous operation.

The world's largest manufacturer devoted exclusively to the production of quality motors and drives is ready to help you widen the horizons of automation in your plant.

Bulletin No. A-1555-B gives further details.

A-1519

ELECTRIC AND ENGINEERING CO.

DEPT. 2612A, CLEVELAND 10, OHIO

Canadian Division: Welland, Ontario • Reeves Division: Columbus, Indiana

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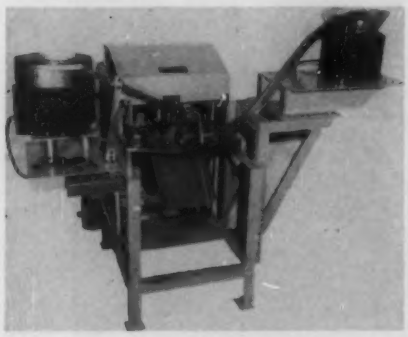
and grit can all be used with equal efficiency by the machines. At the completion of the operation the part holding fixture is again indexed to the unload station. Here the workpiece is stripped from the fixture and slides or rolls down the exit chute for conveying to the succeeding operation. Either manual or automatic loading and unloading can be used with the continuous in-line units. **Modern Industrial Engineering Co.**, 14230 Birwood Ave., Detroit 38, Mich.

Circle 410 on Reply Card



Resistor Capper

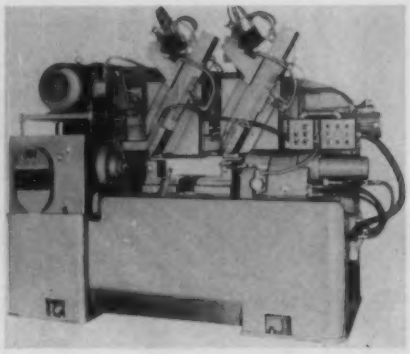
Designed for high production capping of resistor bodies with press fitted terminal caps, automatic machine may be tooled for a variety of resistor bodies ranging in size from 1/16 to 5/16-inch in diameter. Resistor capping machine features vibratory hopper feeds which automatically maintain full chutes for uninterrupted operation. Caps are fed at 100 per minute so that 3000 resistors are assembled per hour.

One machine may be tooled to handle several sizes by simple change procedure. **Special Products Div., Halm Instrument Co., Inc.**, Glen Head Rd., Glen Head, N. Y.

Circle 411 on Reply Card

Double Tracer Lathes

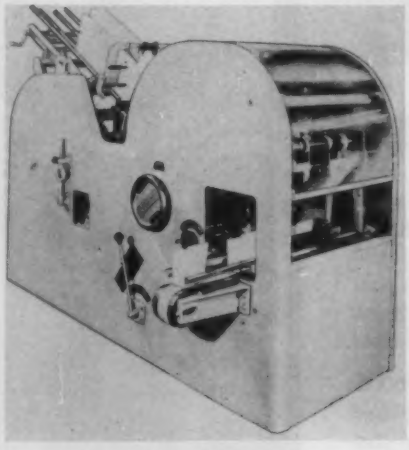
Axle, motor and cam shafts can be handled in a single setup on double tracer lathes. The top arrangement mounts the two tracers in a variety of combinations for efficiency on any installation. Several basic tracer combinations are possible: Either right or left hand mounting of tracers or combination of both, tracers mounted in tandem with a single hydraulic feed



cylinder, or individual feed cylinders supplied for each tracer.

Greater accuracy and time savings are possible since the workpiece does not have to be handled and rechucked twice for separate roughing and finishing operations. The machining cycles are automatic and can be preselected for the particular operation involved. Two different machining sequences are possible: Traversing rear carriage operates first to perform multiple tool roughing operations after which the top carriage tracer slides move in for template controlled tracer turning, or top carriage mounted tracers perform their turning after which the rear slides are used for form tool grooving and undercutting operations. **Hydra-Feed Machine Tool Corp.**, 730 W. Eight Mile Rd., Ferndale, Mich.

Circle 412 on Reply Card

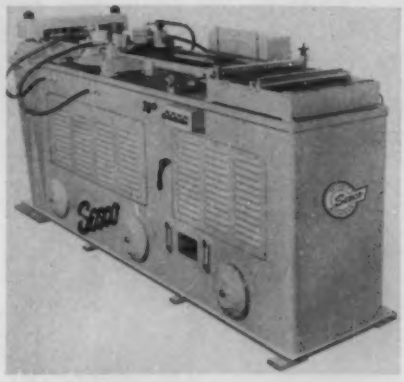


Carton Former

Up to 120 cartons per minute are formed and lined by fully automatic machine. Flat, die-cut carton blanks are fed into the machine from an inclined magazine. Liner paper is fed from a continuous paper roll. The machine automatically cuts paper to the carton size the machine is adjusted to handle, and folds liner papers and carton blanks together to form lined cartons.

Finished, lined cartons are delivered on a moving conveyor with the cover open, ready for carton filling operation. The machine adjusts to handle a wide range of carton sizes. **Peters Machinery Co.**, 4700 Ravenswood Ave., Chicago 40, Ill.

Circle 413 on Reply Card



Blanker Unit

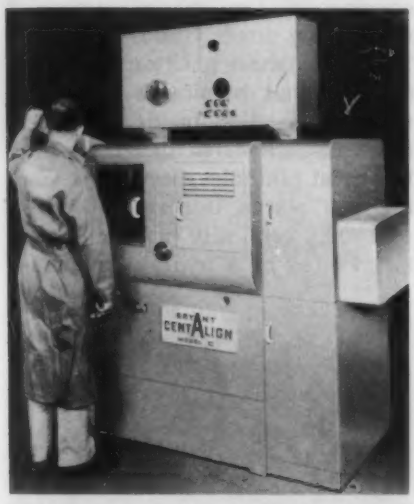
Used to feed stainless steel, aluminum or brass without danger of scuffing, self-contained automatic blanker unit is comprised of three sections. In the first section is a stock lubricator and the lubricant tanks. The lubricator submerges the stock, lubricates it completely on both the top and the bottom and then removes the excess lubricant. Proper level of the lubricant is maintained automatically. A reciprocating pump collects overflow lubricant from the bottom tank and returns it to the upper tank for reuse. Reciprocating pump is activated from the gripper head.

In the second section of the unit is the hydraulic double-gripper feed. An accurate feed stroke is obtained through the adjustable hydraulic cylinder which contains a two-piece piston mounted in tandem. Distance between the two pistons can be changed by turning a stroke adjuster handle which is mounted on the side of the feed unit. Positive internal stops assure the exact duplication of the stroke length. Reciprocating travel of the pinch gripper is governed by the stroke adjustment within the cylinder. Through proper se-

quencing the pinch grip takes place before any forward feeding is possible, and the grip is not released until the forward motion of the gripper head is reversed.

The third section contains a precision cutoff unit. The cutoff is sequenced with the feed cycle and is actuated at the completion of the forward stroke or during the return stroke of the feed grippers. Blanks of a predetermined size are cut off with a minimum waste of stock, ready for feeding into die presses. **Sesco Inc.**, 8881 Central Ave., Detroit 4, Mich.

Circle 414 on Reply Card



Bearing Race Grinder

Designed for long run high production grinding of bearing raceways and taper bores, and for similar operations on various work parts, automatic internal grinder embodies recent developments in shoe centerless grinding and is adaptable to automated lines. The machine, called the Centalign, has workhead, wheelhead and longitudinal and cross slide motions of the wheelslide in one common plane, to reduce deflections to a minimum and to insure better alignment. Vibration absorbers are incorporated in the fabricated bed to dampen all forces and assure fine finishes and accuracy.

Control of machine functions by programming cam sets which can be readily interchanged, makes feasible certain types of recurring short run operations. **Bryant Chucking Grinder Co.**, Springfield, Vt.

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If it's hard to hold...

call Garrison

The harder the holding problem . . . the better we like it!

We specialize in custom-made holding fixtures.

We designed and built the first automated gear chucks in the world . . . all are still in use . . . reorders have been many . . . millions of gears have been made on these automation chucks.

Call us the moment the matter of automation arises, because the part to be processed must be located properly before the machine can do the work.

To automate or not to automate — that is the question

If you are in Standardation* and not ready for the plunge into automation . . . we can design special holding fixtures for your standard machines that will help match the efficiency and production capacities of automated equipment!

If you are already in automation (the process is not new to us) . . . we are prepared to build special holding fixtures for your automated equipment.

Interested?

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GARRISON MACHINE WORKS, INC.

DAYTON 4, OHIO, U.S.A.

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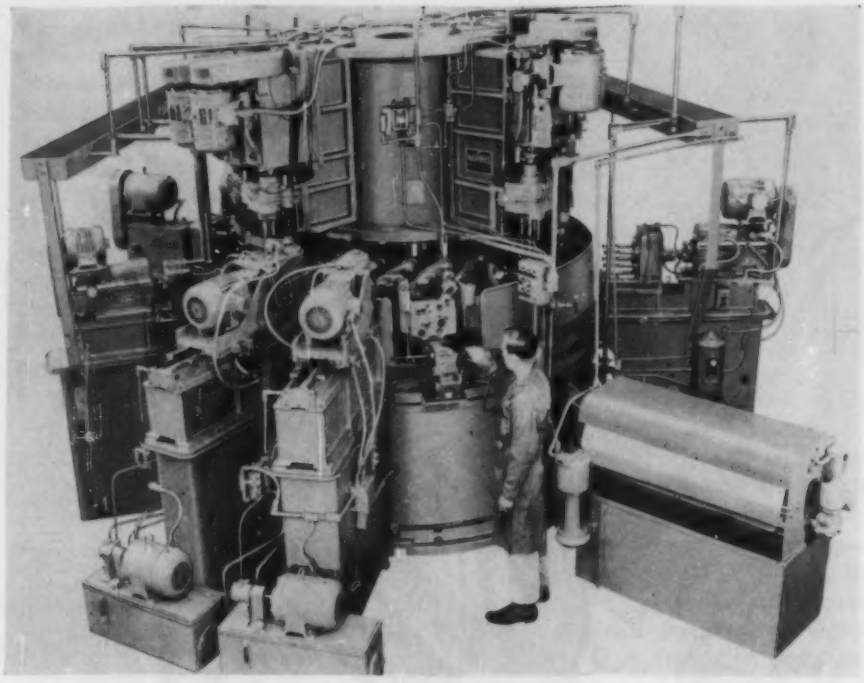


Processing Refrigeration Compressor Housings

Forty-seven operations are performed automatically on one or two-cylinder refrigeration compressor housings by Model 334-S 18-station machine which utilizes an 84-inch diameter table to process 120 parts per hour. The unit-type machine tool eliminates model changeover problems by incorporating standard Morris production units. These are mounted on a basic center column machine equipped with an 18-station hydraulic indexing table.

A total of 47 spindles are mounted on three 8-inch way-type units, six drill units and eight other drill units. They are used to mill, drill, counterbore, spotface, bore, ream and tap housings. Vertical units are mounted on the stationary center column. Horizontal units are mounted on pedestals attached radially to the cast iron base.

Operation is completely automatic. The machine operator loads unfinished pieces into air-powered clamping fixtures and unloads completed parts, at the rate of one exchange each 30.00 seconds. Each of the drill units has independent feeds and speeds, permitting adjustment without affecting the entire machine. All units are controlled simultaneously through an integrated electrohydraulic system. **Morris Machine Tool Co.**, 933-17 Harriet St., Cincinnati 3, O.

Circle 416 on Reply Card

Card Converter

Alphabetically and decimally coded data recorded on cards is automatically translated by card converter into binary language understood by the Alwac electronic digital computer. Unit makes possible the direct and automatic transfer of data from cards to computer for processing. The processed data can then be recorded on cards or tape for storage.

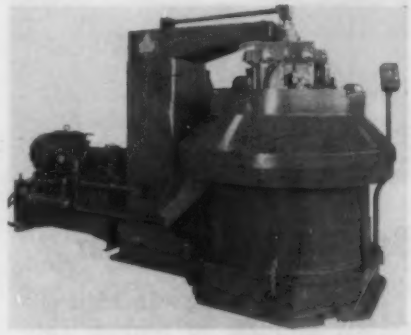
Card converter increases the computer system's range of applications which includes processing payroll, personnel, sales, inventory, production and accounting records, alphabetically and decimally coded on cards. **Logistics Research Inc.**, 141 S. Pacific Ave., Redondo Beach, Calif.

Circle 417 on Reply Card

Piston Scalper

Aluminum automobile engine piston castings are rough turned at the rate of one every 3 seconds with new machine which is adaptable for piston sizes up to 5 inches in diameter and 5 inches in length. Production is based on four vertically mounted work spindles located on a continuously rotating worktable. As the worktable rotates, all movements are controlled by a hydraulic valve in the center column of the machine.

As each spindle passes the operator, he removes the rough turned piston and replaces it with a piston casting. An expanding chuck locates on the inside core of the casting directly under its dome. The chuck shoes position the piston skirt so that turning is in correct relation to the inside diameter. Steel fingers move out to engage the wrist pin holes, securely clamping the piston during the rough cut. The vertically mounted chuck is actuated by a hydraulic cylinder



designed into the work spindle. At each work spindle, a six-step cycle scalps each piston: Chuck clamps rough cast piston; work spindle begins rotation at 2000 rpm; vertical and horizontal tool slides move in simultaneously, rough turning dome and skirt of piston; tool slides retract; work spindle stops and positions to facilitate loading and unloading; and chuck unclamps rough turned piston.

Production of 1200 scalped pistons per hour produces aluminum chips at such a high rate that it is necessary to enclose the whole operation with a shield and to carry chips out a chute at the rear of the machine by means of paddles traveling in a circular trough surrounding the worktable. A conveyor is provided to carry the chips

away from the machine. **Standard-Modern Tool Co. Ltd.**, 373 Front St. E., Toronto, Canada.

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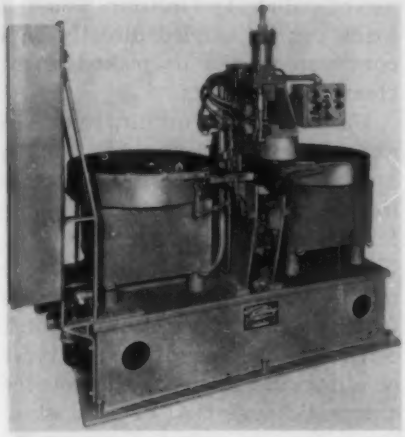

Automatic Assembler

Automotive window lift assembly components are fed, positioned, assembled and unloaded without an operator by automatic assembly machine. Assembly consists of two pieces, a coil spring and a stamped housing. A hook on the spring end must be oriented in proper relation to pierced holes in the housing flange. The housings are fed from a hopper at one side of the machine, while the springs are fed from a hopper at the opposite side. Vibratory feeders are used for both parts.

Each housing is positioned with the open side up. A spring feeds over it, where the spring is compressed and pressed into place by sliding vee members. The assembly is then shuttled under a ram which enters the coil with a locator that prevents the spring from turning. A locating device picks up the locating holes and rotates the housing until the spring end is properly oriented in relation to the holes. Pressing-in and orienting of the spring are done simultaneously, and the same slide that pushes the assembly under the orienting device automatically unloads finished assemblies. Production is controlled by an electronic timer, and the rate is 1440 assemblies per hour at 90 per cent efficiency. **Omer E. Robbins Co.**, 24800 Plymouth Rd., Detroit 39, Mich.

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- Completely tested
- Proven reliable
- Mounting furnished to meet your requirements.
- HUNDREDS OF OTHER DESIGNS for both AC and DC application.
- Push or pull units to 200 lbs. force.
- Send your specifications today.

THE TRADEMARK ON MILLIONS OF SOLENOIDS SINCE 1927

WesCo WEST COAST ELECTRICAL MFG. CORP.

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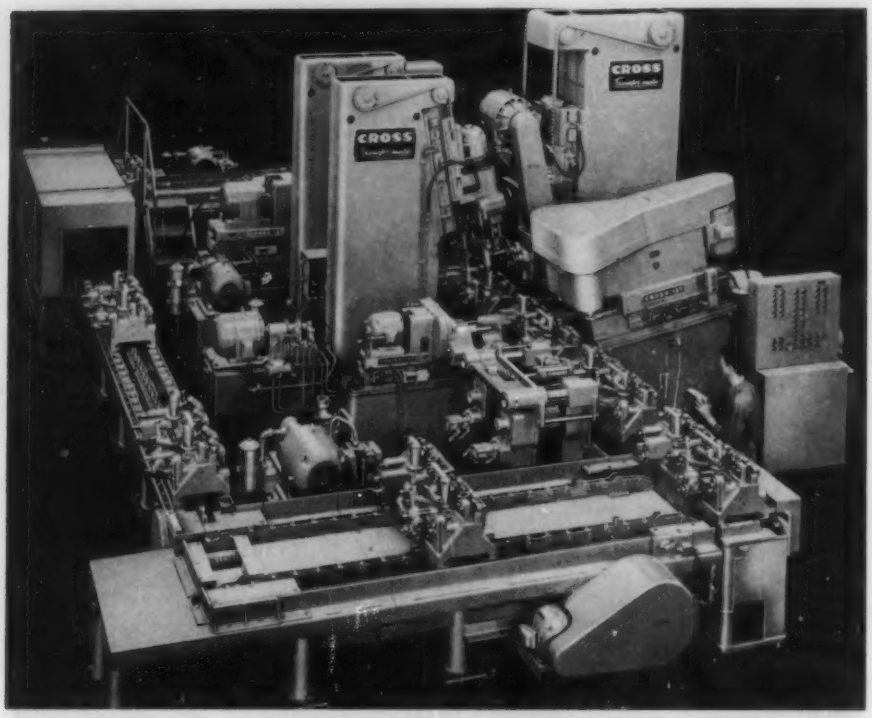
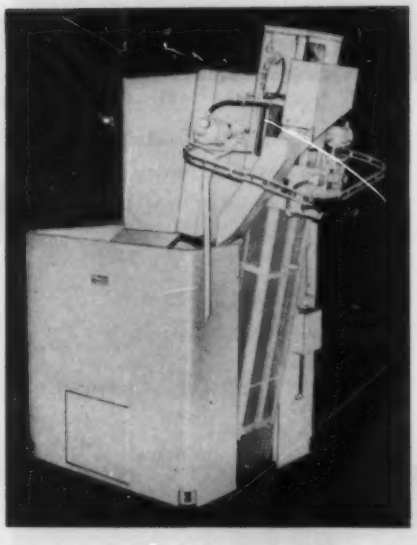


Machining Exhaust Manifolds

Six stations perform 51 operations on V-8 exhaust manifolds—eight milling; 37 drilling, chamfering and spotfacing; six tapping. Transfermatic utilizes modular building blocks to facilitate part design changes and provide standard units for convertibility from one configuration to another.

Feature of the machine is the reduction of downtime through the incorporation of preset tooling which eliminates machine adjustments and trial cuts, reduces tool breakage and grinding costs, minimizes scrappage of work and equalizes operator's time. Palletized work holding fixtures for holding one right hand and one left hand manifold are provided; fixtures are automatically operated by a hydraulic power wrench. **Cross Co.**, 3250 Bellevue, Detroit 7, Mich.

Circle 420 on Reply Card



Large Hopper Feeder

With a 45 cu ft hopper capacity, Model 2500B automatic feeder serves as a storage space for parts, prevents floor cluttering with boxes of parts, and feeds parts through multiple chutes to production machines, assembly lines, etc. Range of work for rolling parts is 5 inches in diameter and 3/16 to 1½ inches long; for sliding parts from 3/16 to 2 inches in diameter and up to 5 inches long. Power is furnished by a 1½ hp 220/440v, three-phase motor operating through a variable speed drive.

In operation, parts are placed in the hopper, are picked up by the elevating conveyor and discharged through the multiple chutes to the machines or places where they are used. **Feedall Inc.**, Willoughby, O.

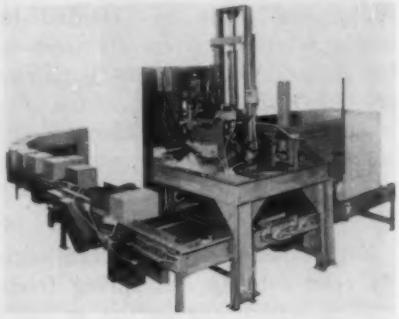
Circle 421 on Reply Card

Carton Stacker

Unit loads of cartons or cases are automatically assembled in desired size and shape directly from connected conveyor without the use of pallets by Unitizer. The unit loads can be carried directly on a conveyor or can be picked up by clamp type trucks.

Unitizer works on air, hydraulic and electrical circuits. It handles a variety of package sizes, arranging them in interlocking or noninterlocking patterns as required. Number of tiers in each unit load can be varied. The device can be furnished with a selector switch control mechanism of several types or automatic sequence controls for automatic variation of load sizes. Control panel switches are so designed to enable all functions of the Unitizer to be tested separately. Only three motors totaling less than 7 hp are required for the complete automatic functioning of the unit.

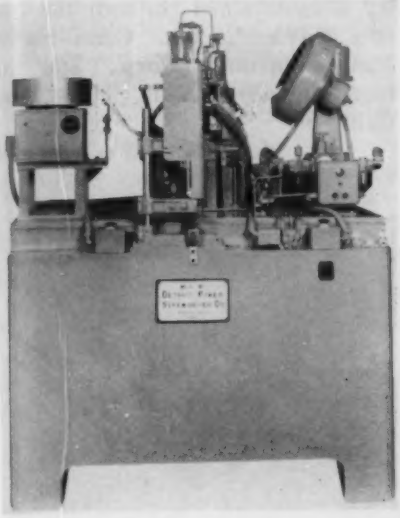
In operation, packages are conveyed into the Unitizer in single file. Upon entering the machine



the packages are automatically positioned into the pre-established pattern. When the layer or tier has been formed it is automatically moved to a secondary position and the succeeding tier formation is begun. The first tier is then picked up by the clamp arms and raised high enough to clear the succeeding tier being moved to the second position. When the second tier is in the second position, the clamps automatically lower the first tier to the top of the second tier and then continue down to pick up both tiers. The operation is repeated until the predetermined number of tiers are in the clamp position. The total unit load is then lowered and conveyed automatically to a discharge station

for pickup by the clamp truck. **Standard Conveyor Co.**, N. St. Paul 9, Minn.

Circle 422 on Reply Card



Assembling Hangers

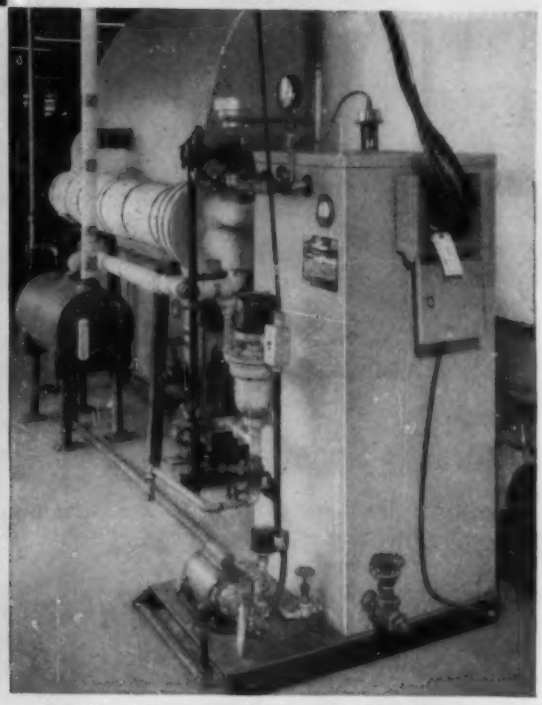
Built to assemble the rolling hangers for sliding doors, sliding screens, etc., semiautomatic machine uses three feeding devices, two of which are illustrated and one hidden. Units feed the three hanger components—the shoulder rivet, bronze bushing and nylon roller.

The three components are assembled as follows: The nylon roller is fed from a vibratory feeder into an indexing dial. The bronze bushing or bearing is fed from another vibratory feeder and pressed into the nylon roller. At the next index the shoulder rivet is fed by means of a barrel or rotary feeder and inserted into the preassembled roller and bushing. The completed assembly is then ejected into a track twisted 180 degrees which feeds the completed three-part subassembly into a locating fixture. The operator then places the steel bracket over locating pins in the fixture and touches two palm switches which, in turn, cycle the pneumatically operated impact hammer. At the point of assembly, the hollow body of the shoulder rivet is flared, completing an integral assembly with a free-running, self-lubricating nylon roller. **Detroit Power Screwdriver Co.**, 2801 W. Fort St., Detroit 16, Mich.

Circle 423 on Reply Card

Pantex Speedylectric Steam Generator

Ideal Steam Source for Production Processes



Speedylectric Steam Generator supplying heat to waxer.

Manufacturing huge quantities of waxed paper containers of every size and shape, a nationally-known company needed a reliable source of heat for a production step in which the new containers are deeply impregnated with a special hot wax. Here, as in many manufacturing processes, a Pantex Speedylectric Steam Generator was the answer.

In the impregnation process, accurate control of wax temperature and submersion time is required for dimensional control of the finished product, complete wax penetration and stability of ink colors. The use of a Speedylectric Steam Generator as a heat source not only assures reliable temperature control at modest cost, but eliminates all danger of fire or explosion . . . serious hazards where the plant atmosphere is often full of particles of waxed paper.

Wherever a reliable, convenient, safe source of steam is needed, Speedylectric Steam Generators serve industry. Using a unique electrode method to generate steam, and easily portable, they require no supervision, operate without flame or fumes, and eliminate the risk of fire or explosion.

WRITE TODAY FOR COMPLETE FACTS AND FIGURES

Speedylectric Steam Jet Cleaners, too, serve industry in countless ways. High pressure jet of dry steam and solvents quickly removes grease and dirt accumulations from machines and equipment without flooding floors. No need to stop nearby production or move machines outside. Completely safe and portable.

PANTEX MANUFACTURING CORPORATION
Box 660AI, Pawtucket 12, R. I.
Send me facts and figures on:
☐ Pantex Speedylectric Steam Generators
☐ Pantex Speedylectric Steam-Jet Cleaners

Name and Title.....

Company.....

Address.....

Circle 582 on Inquiry Card

Recording Gage

Used to check strip stock as it is feeding to punch presses, continuous measuring recording gage is designated Model 493 B-139. Gage is mounted in a wheeled cabinet and is placed between a feed roll and a punch press so that the strip stock goes through the gage before it reaches the press. The gage can easily be moved from press to press as needed. By checking the stock continuously and observing the gage meter hand or the recorder chart, the thickness trend of the stock can be followed. The response of the gage is deliberately dampened so that local irregularities will not show and the gage will see an average stock thickness. The recorder chart provides a permanent record of the thickness variation of each roll of strip stock which can serve as positive evidence of the condition of any particular roll. It can also be studied for information regarding the effect that various thicknesses have on the finished stampings.

Illustrated gage is adjustable to measure stock from 0.015 to 0.100 inch thick and from 5 to 18 inches wide. The stock passes between two crowned rollers on the gage, the bottom one being the reference contact and the upper one the sensitive or measuring contact. As the stock varies in thickness, the action of the sensitive contact is transferred to an electronic amplifier which moves the meter hand and the pen of the recorder. Stock items can be added to the basic gage that will enable it to signal the operator with lights or sound signals when bad stock is going through, or to make the gage trip a switch to shut off the feeding mechanism when the stock is out of tolerance. **Federal Products Corp.**, 1144 Eddy St., Providence 1, R.I.

Circle 424 on Reply Card

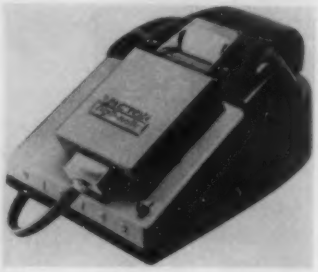
Process Refractometer

Designed to monitor continuously the refractive index of liquid process streams in refineries and chemical plants, process refractometer is known as Type 38-202. Device is an improved version of an earlier type which was successfully used in the automatic control of liquid stream blending and fractionator-tower operation.

Refractive index provides a direct indication of relative composition changes in binary mixtures. The refractometer measures the difference in refractive index between a sealed-in liquid standard and a flowing sample drawn directly from a process line. This measurement is based on the bending effect caused by passing a ray of light from one medium to another of different refractive index. Beam deflection is proportional to refractive index difference and is readily measured by an optical servosystem. A telemetering circuit provides a servosignal for strip or circular chart recording, or for direct control.

Freedom from rapid ambient temperature changes is achieved by an insulating barrier surrounding the entire optical measuring unit. Sample temperature stability is maintained through the use of a heat exchanger. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle 425 on Reply Card



Digital Printers

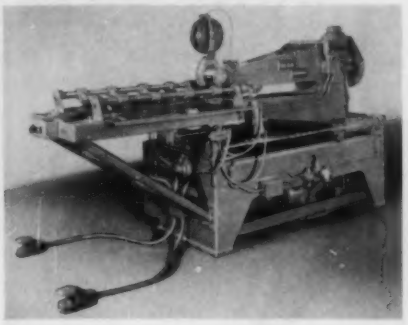
Used with paper tape punches and readers, punched tape typewriters, electronic counters, digital testing equipment, analog to digital devices, time interval meters, pulse height analyzers, digital scales, production counters, and for such integrated data processing office applications as automatic invoice calculating, purchase order extensions, etc., digital printers are called Digit-matics. Units are basic adding, multiplying or calculating machines equipped with electrically actuated keys, and are available in serial and parallel entry models.

Serial entry printers are basic ten-keyboard adding machines having numerical keys, 0 to 9. Digits are entered in sequence starting with the most significant digit. The adding machine automatically indexes the digits one column to the left as each digit is entered. After all the digits of a figure have been entered, a single depression of the motor bar by its solenoid causes the Digit-matic to print the data line and transfer the figures into the accumulator. Serial entry models are available as listers, accumulators, multipliers and calculators.

Parallel entry models are basic full keyboard adding machines. All columns are equipped with a set of 1 through 9 keys, each of which has a solenoid for electrical actua-

tion. Zeros are automatically printed to the right of the most significant digit and automatically suppressed to the left of the most significant digit. High speeds are possible with this model; the parallel entry lister can print 185 lines per minute. Parallel entry Digitmatics are available as listers and accumulators. **Victor Adding Machine Co.**, 3900 N. Rockwell St., Chicago 18, Ill.

Circle 426 on Reply Card



Automatic Stitcher

Designed to provide greater daily outputs and more continuous operation of annealing, galvanizing, painting, coating and other continuous line processing, automatic stitcher permits the leading end of a new coil to be joined to the trailing end of the preceding coil in minimum time. Operator aligns the trailing end of the lead coil and lead end of the new coil in the stitcher with a 3 to 5-inch overlap and clamps them tight. The standard 36-inch stitcher (illustrated) automatically joins the two pieces together with 14 locked stitches set in parallel rows 2 inches apart in from 15 to 20 seconds. Movement of the stitching head is interrupted momentarily as each stitch is made to avoid any deformation of the stitch, and to assure the formation of a locked joint having maximum strength.

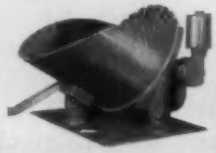
Load strength of three stitches is said to be equal to joining the two pieces together with a ⅛-inch steel rivet. The joint is only about 0.1-inch greater than the total thickness of the two pieces of material joined, passes over rolls easily, and can be used at elevated temperatures without difficulty. The 36-inch stitcher adjusts itself automatically to stitch narrower than a 36-inch wide strip. Stitch-

You Can be Sure of 2 WAY BENEFITS PRODUCTION PROFITS When You Use

DPS POWER SCREWDRIVERS and other Assembling Equipment

Present Owners Report a SHARP GAIN in OUTPUT and a RISE in PROFITS!

Important Reasons why you, too, should benefit from greatly stepped-up, lower-cost production and the wider profit margin that naturally follows . . . These 2-way advantages of DPS Power Methods have been proved in over a quarter century of service to modern industry . . . If you are still using out-moded assembling methods, change now . . . Get the facts about the extensive DPS line. No doubt we have a product that can be adapted to your requirements. Write today.



BARREL FEEDER with stationary ring cover, for heavy-duty, large production runs

BOWL FEEDER Vibratory type, to select and feed smaller fragile parts

DPS SELECTIVE PARTS FEEDERS

Modern Necessities Widely Adaptable

These versatile devices not only provide the feeding operations on Detroit Power Screwdrivers, but they are being widely used on today's many special high-production machines.

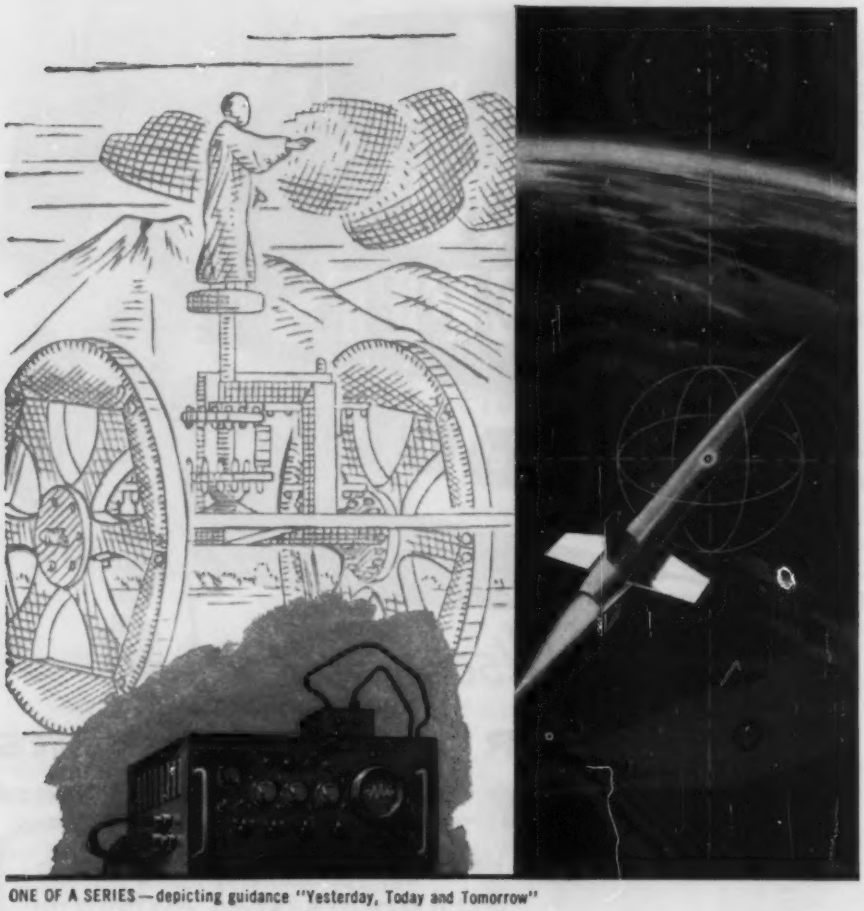
5 SCREW-DRIVING MACHINES Bench and Pedestal types. Pedestal Model A pictured

WHAT IS YOUR FEEDING AND ASSEMBLING PROBLEM? WRITE US—ALSO SEND SAMPLE ASSEMBLY

DETROIT POWER SCREWDRIVER CO.

2811 W. FORT ST. DETROIT 16, MICHIGAN

Circle 583 on Inquiry Card



ONE OF A SERIES—depicting guidance "Yesterday, Today and Tomorrow"

navigation is a problem

From the ancient Chinese comes one of the earliest known directional devices. Not the magnetic compass of legend, but a mechanical compass with differential gears for maintaining a constant south-pointing position. It was used by Yellow Emperor Hunag Ti about 2634 B. C. to guide his armies across the vast steppes leading to the sunny, fertile lands of the south.

Many forms of navigation have been developed since, each system requiring greater scientific knowledge. One of today's systems is inertial guidance, a complex integration of electronics and servo mechanisms utilizing the best that present technology can provide.

At Bell, problems in navigation or guidance have been answered in many ways . . . missile guidance systems . . . a recovery system used in several missiles . . . and a landing system for aircraft in all types of weather.

Bell offers an unparalled opportunity to the progressive engineers who desire assignments that demand creative thinking. Engineers with a B. S. or advanced degree in :

SERVO SYSTEMS ENGINEERS
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TRANSISTOR APPLICATION SPECIALISTS
DIGITAL COMPUTER DEVELOPMENT SPECIALISTS
ELECTRONIC DEVELOPMENT ENGINEERS

please contact

MANAGER, ENGINEERING PERSONNEL DEPT. D.

BELL Aircraft CORPORATION

P. O. Box 1 Buffalo 5, N. Y.

ers are also available to stitch wider than 36-inch strips.

A twin cut shear developed for use with the stitcher removes a 6-inch wide section of strip, including the stitched joint, in just one cut of the shear, leaving a square-cut end ready for recoiling. **Herr Equipment Corp.**, 1200 Vine St., N.E., Warren, O.

Circle 427 on Reply Card

Switch Rail

Featuring an automatic guard rail, Flex-A-Switch unit is suitable for high speed travel and is recommended where cartons, cans or boxes are coming down at 100 fpm or faster. It can be furnished where shifting of the switch is electric (illustrated), pneumatic or manual, and controls can be remotely installed, or on a master pushbutton board with limit switches controlling the positioning of the rollers.

Flex-A-Switches, equipped with automatic guard rails and used in a series, make possible an infinite number of patterns of travel in either direction with a selective track *To* and a selective return. The switch (shown on a portable stand) is usually installed as part of a permanent conveyor line and is mounted on permanent stands with controls at a point suitable for operation of the entire conveyor system.

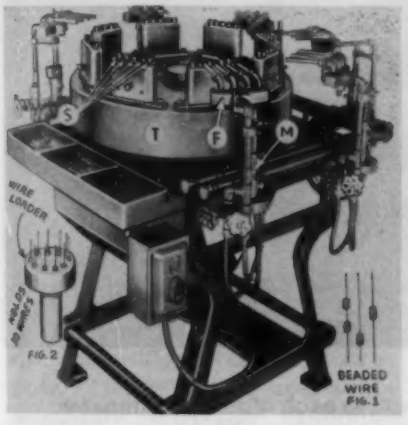
Unit operates through a 45-degree arc and to accomplish a 90-degree turn, a 45-degree curve is added to the end of the switch which is furnished 45 degrees *Right* or *Left*, or is furnished through and 45 degrees *Right* and *Left*. Dual automatic rails can

be furnished and are recommended for maximum safety in overhead installations. Standard change of direction is accomplished in eight full turns of the crank in manual operation — 6 seconds for electric control, and 3 seconds for pneumatic operation. **Metzgar Conveyor Co.**, 408 Douglas St. N.W., Grand Rapids 4, Mich.

Circle 428 on Reply Card

Glass Beading Machine

Designed for melting glass beads onto wire, new machine is used in construction of diodes, radio tubes and other electronic devices. Machine includes such features as: (*T*) a turret which indexes intermittently by means of an eight-station Geneva gear located on the underside of the turret; (*S*) a nest of five rotating spindles in each of the eight stations. Each rotary spindle accommodates ten



wires in the beading operation. This combination has a productivity of 25,000 wires per hour when the machine is operated at a speed of 500 indexes per hour. (*F*) The burners using gas and air provide the proper heat for melting the glass to the wire. Micrometer adjustment (*M*) makes possible accurate adjustment of the gas burner flames. The gas burner system has been developed for use with manufactured gas and low pressure air, but can be modified to use natural gas as well as bottled gas. Machine can also be used for annealing, brazing, soldering, flame hardening, spraying and other applications where rotating and indexing are necessary. **Eisler Engineering Co., Inc.**, 750 S. 13th St., Newark 3, N.J.

Circle 429 on Reply Card

Why AIR Tools?

Because air is everywhere, just waiting to be put to work . . . because continuous operation can't possibly harm an air tool . . . and because, if you're using Buckeye air tools, you can almost forget about tool maintenance.

This Buckeye Tools multiple-unit fastening tool runs down six hex head bolts simultaneously. It could be designed to handle more bolts, different sizes of bolts, or to run them down at different levels at the same time. Or, it could run down bolts at various angles, even straight up!

This is just one of many new Buckeye fastening tools. Are you sure you're doing your fastening work the modern way? Our Catalog A-10 will help you decide—and it's yours for the asking.

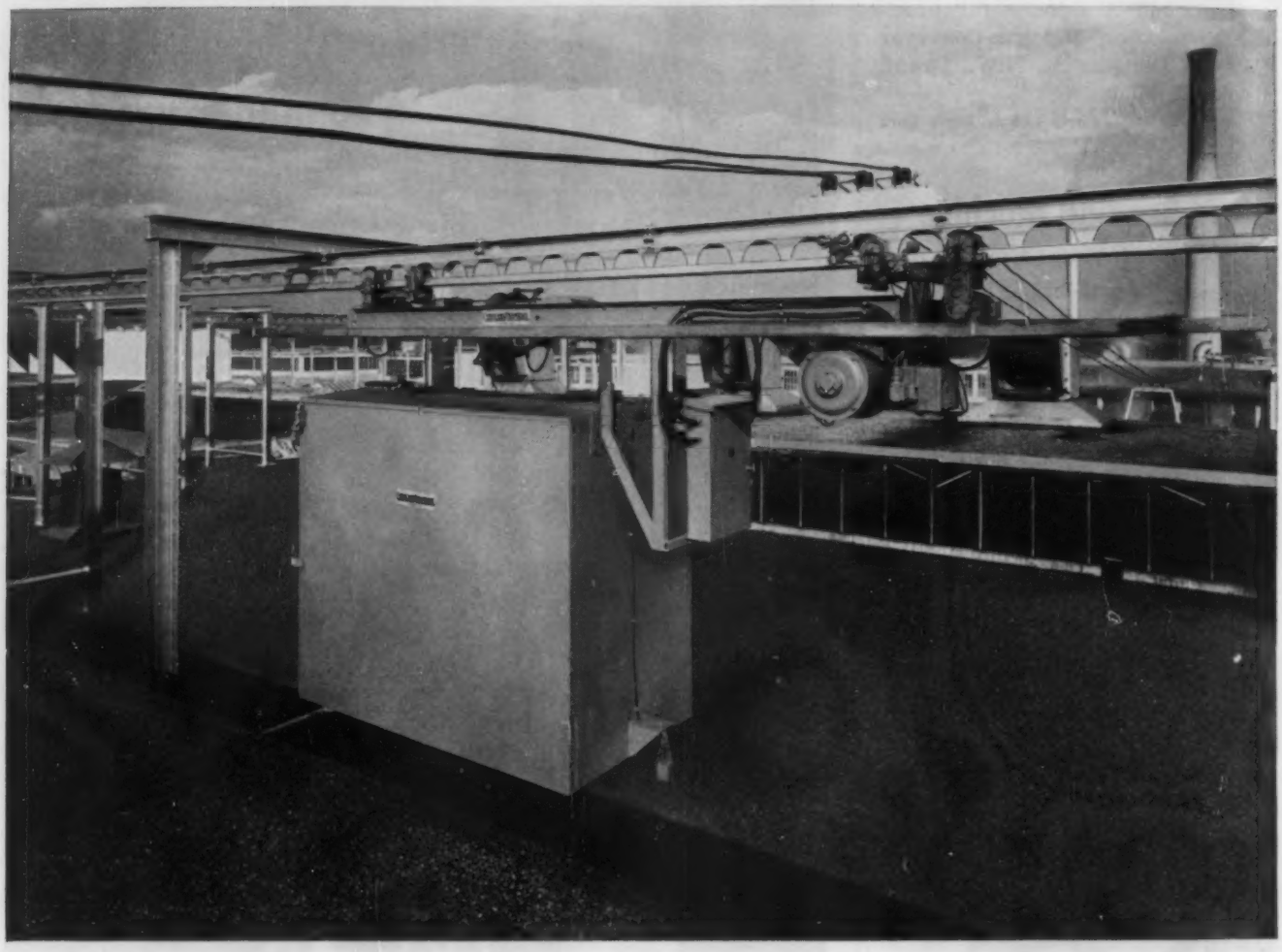
In Air Tools, Your Best Buy Is Buckeye

Buckeye Tools
CORPORATION
DIVISION 12 • DAYTON 1, OHIO

Circle 585 on Inquiry Card

AUTOMATIC Materials Handling System Operates On Roof

Has paid for itself several times over since installed



THE box-like structure that you see in the photograph above is a traveling van that measures 4'-0" x 8'-0" x 6'-6" high. It is built into a motorized carrier that travels over an extensive Cleveland Tramrail system built on the roof of a large prominent plant.

A large door at the opposite end of the van is swung open during loading. Pallet loads of materials are brought inside the van and set in place. 3000 lbs. can be handled with this particular unit per trip. Other larger units are available.

No special operators are required for the Tramrail system, as it can be kept going easily by the production machine operators along with their regular work. After the van is filled, pressing a button starts the load on its way. The van first travels upward until it is above the roof. Then it goes forward over the extensive track system. When it reaches the roof over one of the two receiving stations, as preselected, it makes the vertical descent to the floor. Here the door is opened and materials removed.

This system brings distant departments close together so that they can operate as efficiently as if they were adjacent to each other. It eliminates need of wide load-carrying aisleways — and thereby saves considerable floor space. It avoids confusion and danger of floor trucks which would normally be required. It greatly cuts costs by drastically reducing time required for materials handling. In fact, the savings made by this system have been so great that it has paid for itself several times over since installed.

Very likely you, too, can make big savings by putting to work that big unused roof of yours. Cleveland Tramrail engineers stand ready to show you how.

CLEVELAND TRAMRAIL

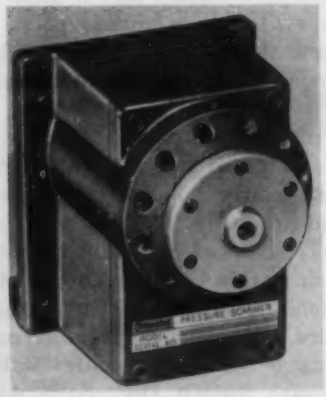
Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1320 E. 290 ST. • WICKLIFFE, OHIO

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 17



Pressure Scanner

Designed to enable the measurement of up to 12 pressure sources with only one transducer, Datex pressure scanner not only reduces the number of transducers required for multiple pressure measurement but can be used to increase accuracy of measurement with presently available components. Device can be used to automatically introduce calibration and/or zero pressures during each scan cycle, permitting calculation of exact transducer response, thus enabling greater accuracy. Transducer is vented to atmosphere between pressure ports, eliminating transducer hysteresis effects, thereby contributing to greater measurement accuracy.

The SP-101 pressure scanner consists of a stator having 12 input ports, and a rotor that connects any one of the 12 input ports and an output port. The rotor is rotated to a desired position by a unidirectional high torque motor whose operation is controlled by means of a positive positioning arrangement. A relay circuit is incorporated in the unit to provide dynamic braking in order to stop the motor in a position where the rotor and stator ports are in coincidence. An additional bank of contacts is provided on the internal switch so that indication of the rotor position can be obtained either visually or digitally for operation of recording devices. Positive positioning allows points to be skipped or scanned in any desired sequence by remote control. By using one scanner to interrogate 12 others, as many as 144 pressures can be measured with only one transducer. **Datex Div., G. M. Giannini & Co. Inc.,** 1307 S. Myrtle Ave., Monrovia, Calif.

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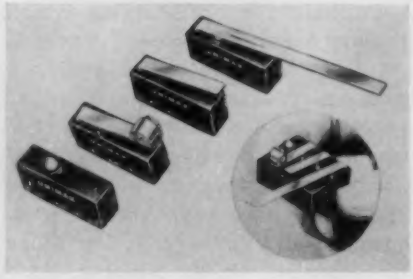

Snap Acting Switches

Actuators integral with the switch body provide ease of installation and maintenance of factory set switch characteristics for Type USM switch. The small size and unobstructed, flat sides of the switch permit easy ganging of four switches per inch in miniaturized apparatus. Switch measurements are ¼-inch thick, 9/16-inch high and 25/32-inch long, depending upon what type of actuator is used. Four types of actuators are available—the basic pin type, leaf, long leaf and leaf roller. Rated at 5 amp, 125/250v ac, the switch is single-pole, double-throw. **Unimax Switch Div., W. L. Maxson Corp.,** Ives Rd., Wallingford, Conn.

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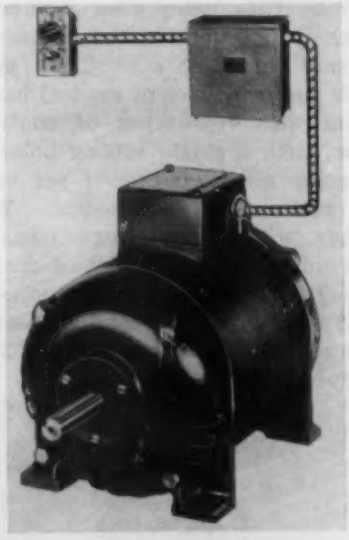

Adjustable Speed Drives

Adaptable for use in automatic control devices, 300 Series adjustable speed drives have ¼ and ½-hp models which are available with either geared or nongeared motors. Motor armature delivers a constant torque at a speed that is infinitely adjustable from near zero to 2400 rpm. Control head utilizes low voltage circuits that can be easily installed at a point remote from either the motor or rectifier cabinet.

Concrete-like epoxy resin is used to enclose all resistors, condensers, etc. within a single plug-in assembly. Models with reversing control and dynamic braking have low voltage relays. **Servo-Tek Products Co. Inc.,** 1086 Goffle Rd., Hawthorne, N. J.

Circle 432 on Reply Card

Temperature Controller

Designed for specialized temperature control applications such as heating followed by automatic cooling, directing motor operated fuel

valves, controlling of high temperature with automatic reset provisions, three-position pyrometer temperature controllers are used with plastic extruders, industrial ovens, furnaces, etc. They provide for two types of neutral band, each with two types of control. One, with a single setting pointer, permits no more than 1 per cent of scale range as neutral. The other, with two settings, permits spread up to 20 per cent of range. *On-Off* or proportioning type control is available. **West Instrument Corp.**, 4351 W. Montrose Ave., Chicago 41, Ill.

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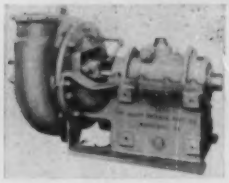


Centrifugal Pumps

Designed for transporting mixtures of abrasive materials such as ash, slag, and fly ash from power plants and coke from petroleum plants, line of centrifugal pumps is known as the Hydroseal line. Pumps are available in two types and many sizes. One type employs rubber, neoprene or other synthetic lining and is suitable for pumping fine solid materials, especially where resistance to chemical action is important. A second type employs hard metal alloy wearing parts and is suitable for handling sharp edged solids that would tend to cut the softer, nonmetallic linings.

In operation, a small stream of clear water flows continuously through the clearance spaces between the rotating impeller and the stationary parts into the shell and suction eye of the impeller. The clear seal water protects the shaft, stuffing box and suction seal from abrasive-laden water and thus eliminates possibilities of frictional wear and enlargement of running clearances between moving parts. It also prevents recirculation of the solid-fluid mixture back to the suction eye of the impeller, thereby eliminating inefficiencies of double pumping. Since there is no need to compensate for wear, any fixed pumping condition can be maintained without changing motor or pump speed. **Allen-Sherman-Hoff Co.**, 259 E. Lancaster Ave., Wynnewood, Pa.

Circle 434 on Reply Card

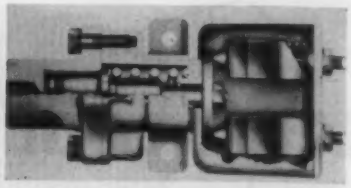
Palm Button Valve

Suitable for applications which require a normally closed straightway or three-way hand operated pilot valve, leak-proof palm button valve is designed specifically for use in circuits where safety is of prime importance. Valve can be provided with a tumbler type lock, enabling it to be locked in either the open or closed position. Although the valve is ¼ NPT side ported, its overall height is only 2⅜ inches. The three-way model has a nonpiped exhaust and both straightway and three-way have a ¼-inch diameter flow capacity. **Ross Operating Valve Co.**, 120 Golden Gate, Detroit, Mich.

Circle 435 on Reply Card

Piston Pressure Switch

Capable of sensing two different pressures in one system and actuating independent electrical circuits at any two desired points, piston pressure switch has dual setting. Designated Models 9622 and C9622, the units may be used to maintain a pressure where it is necessary that system pressure does not exceed or fall below predetermined



values. Switches accurately sense any system pressure over an adjustable range of 15 to 3000 psi for proof pressures from 3000 to 7000 psi, depending on the switch setting. A switch incorporates two single-pole double-throw snap action switching elements rated for ac and dc circuits. Each switching element is electrically independent of the other.

Pressure settings are made by two external adjustment screws which can be locked in place to avoid accidental disturbance. Model C9622 has two calibrated dials which enable the user to set either switching element, without gages, before or after installaton on a pressure line. **Barksdale Valves, Pressure Switch Div.**, 5125 Alcoa Ave., Los Angeles 58, Calif.

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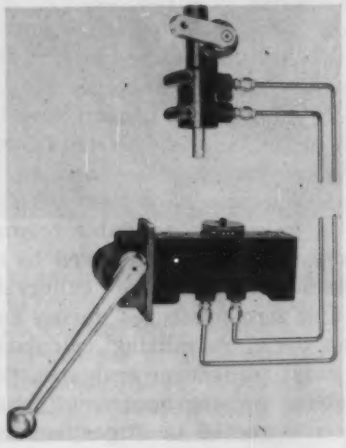

Remote Control Unit

Applicable in any installation where it is desired to move or position an object at a distance from the control station, double-acting remote control unit can carry a full load in both directions. Two tubes connect the master and slave units, replacing the usual rods, cables or push-pull controls. Remote control is fully temperature compensated and will stay in synchronization during wide temperature changes. **Hydronic Co.**, 22226 Fenkell, Detroit 23, Mich.

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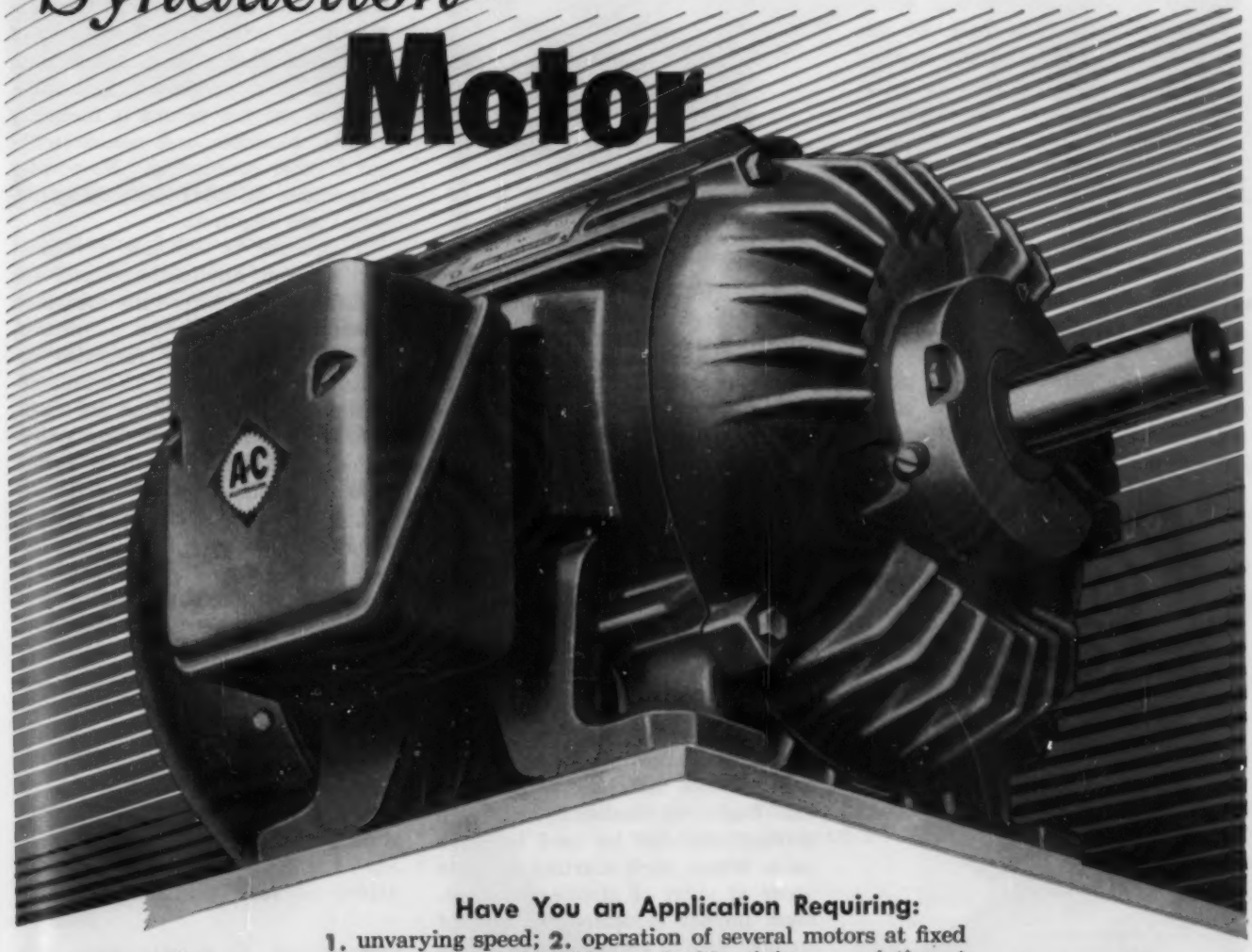
NOW dependable constant speed at less cost

Here's a motor with all the constant speed benefits of synchronous design at initial low cost — with the dependability of an induction motor. It's the NEW *SYNDUCTION* motor, built specially for applications from ¼ to 40 hp.

DEPENDABLE — Now constant speed, regardless of load or voltage changes, is sure . . . depends only on frequency. *Synduction* motor's simple die-cast rotor has no brushes, collector rings, nor insulated rotor windings.

LOW COST—Simple across-the-line control is all that's needed. Further, design permits use of frames smaller than usual reluctance-type motors. Purchase price is well below that of ordinary reluctance-type motors.

New *Synduction* Motor



Have You an Application Requiring:

1. unvarying speed; 2. operation of several motors at fixed speed ratios; 3. adjustable speed with minimum variation at any speed setting? If so, Allis-Chalmers invites your inquiry. Contact your nearby A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin, for Bulletin 51B8440.

Synduction is an Allis-Chalmers trademark.

A-C ALLIS-CHALMERS

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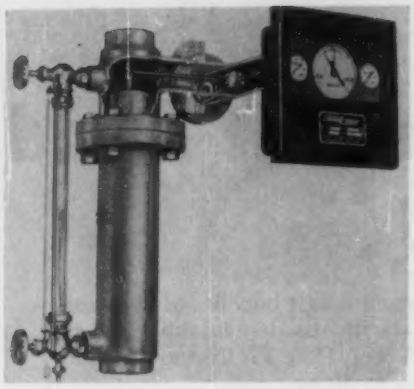
ALLIS-CHALMERS

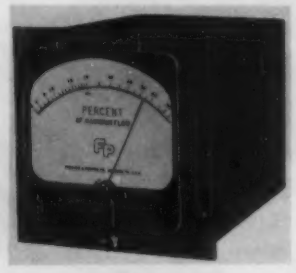


Level Controller

Design of displacement type liquid level controller has eliminated both bearings and knife edges. Called the Flexotrol liquid level controller, the unit has a torque table which replaces pivoting members. The face of the torque table, engaging and driving the torque tube, is free to twist under the action of the displacer.

Controllers are available with external displacer chambers or in models for direct displacer immersion in the process vessel. As an optional feature, direct mechanical liquid level indication can be provided as a final and complete check on the pneumatic system. Direct reading scales simplify adjustment for a broad specific gravity range. Control action is interchangeable for proportional or differential gap response; proportional band is 1 to 150 per cent with automatic reset as an extra feature. **Kieley & Mueller Inc.,** 64 Genung St., Middletown, N.Y.

Circle 438 on Reply Card



Flow Rate Indicator

Developed for use with F&P turbine type primary metering elements, flow rate device is known as the Industrial Logarithmic Panel Indicator. Unit converts the output signal of the turbine meter into a series of pulses of constant amplitude at a frequency equal to that of the turbine meter output and therefore, proportional to volumetric flow rate.

Pulses are integrated in a dc milliammeter providing an indication proportional to frequency and hence to flow rate. External terminals are provided for pulse and dc millivolt output signals. A shaded pole panel meter with a logarithmic characteristic is employed to provide uniform rate accuracy of 2 per cent at a short term repeatability of 0.5 per cent of rate. **Fischer & Porter Co.,** Hatboro, Pa.

Circle 439 on Reply Card

Rotary Solenoid

Recommended for special machinery and automation applications where compact, fast-action power is needed to rotate valves, gates, escapements, etc., 800 Series ac rotary solenoid features built-in return springs. Eliminating the need for remote springs and extra assemblies to return load to starting position after solenoid work stroke is complete, the built-in return spring offers a packaged power unit for simple installation to the load.

Wide selection of springs available permits matching of solenoid to load requirements. Return springs can also be used to drive loads where high starting torques occur at start of stroke and minimum impact is desired at end of stroke. Use of return stroke action permits smaller solenoid sizes. Device operates on standard voltage, 60 cycle, ac power. Rotary strokes up to 60-degree maximum and torques up to 75 inch-lb are possible. **Leetronics Inc.,** Dept. 25, 30 Main St., Brooklyn, N. Y.

Circle 440 on Reply Card

Recording Oscillograph

Visicorder is the name of recording oscillograph which combines the high frequency and sensitivity characteristics of a photographic oscillograph with the convenience of a direct writing instrument. The device records frequencies up to 2000 cps. Sensitivity of its galvanometers is comparable to that in photographic type oscillographs, yet the record is instantly visible, readable and usable without further processing. No powder magazines or other processing material are required.

Visicorder is suitable for most oscillograph applications, and for additional uses where the measured phenomena need to be monitored, or where immediate recorded results are necessary. The unit accommodates as many as six channels on a 6-inch chart. Its galvanometers deflect a full 6 inches peak to peak. Chart speeds are 0.2, 1, 5 and 25 inches per second, minute or hour. Instrument accommodates 100 ft of record. **Heiland Div., Minneapolis-Honeywell Regulator Co.,** 5200 E. Evans Ave., Denver 22, Colo.

Circle 441 on Reply Card

Tachometer Takeoff Head

Used with Metron indicators, Series 34 tachometer takeoff head measures speeds between 100 and 5000 rpm. Devices are available with A.N. screw mounts for aircraft tachometer takeoffs, and also

with S.A.E. screw mounts for gasoline, diesel, marine, railway or stationary engines and compressors. No brushes or slip rings are used.

A double-pole, double-throw switch with a capacitor senses speed when the takeoff shaft rotates either direction. A current, linear with respect to speed, is transmitted to a centrally located indicator up to 1000 ft away. Since these takeoff heads use a dpdt switch (not a generator), they must be combined with a Metron indicator. **Metron Instrument Co.,** 432 Lincoln St., Denver 9, Colo.

Circle 442 on Reply Card

Power Positioner

Featuring torque capacity independent of error signal magnitude, high speed operation without overshoot or oscillation, small size actuator with high torque capacity and positioning accuracy with low dead band, remote power positioners are designed for industrial applications. Units operate from 115v ac, 60 cycle power. Basic components are an amplifier and a high torque motor having good starting and stopping features.

The amplifier supplies power to the motor as required to cause the feedback potentiometer to balance the position manually set on the potentiometer mounted on the amplifier. Torque capacities are up to 100 inch-lb, depending on output speed, for which standard gear ratios are available up to 100 rpm. Actuator output speed corresponds to speed of input control up to the limit of the specific actuator which is used.

A separate input for control from other transducers or switching circuits gives the system flexibility for any application where automatic programming or remote positioning is required. **Globe Industries Inc.,** 1784 Stanley Ave., Dayton 4, O.

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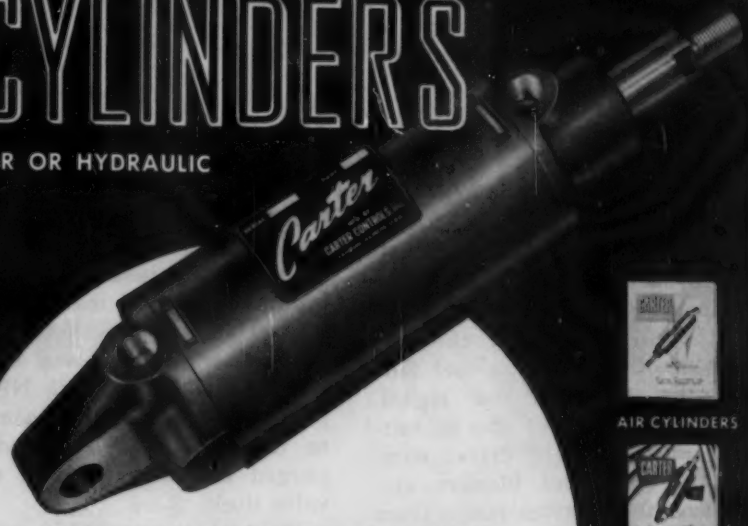
HERE'S WHY **CARTER** CAN OFFER

IMMEDIATE DELIVERY

ANY BORE SIZE • ANY MOUNT • ANY STROKE

CYLINDERS

AIR OR HYDRAULIC



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  Carter is geared to give service. We have increased our plant capacity to handle orders on an IMMEDIATE DELIVERY basis.
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  Carter cylinders are designed for fast production and immediate off-shelf assembly from standard parts.
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ROTARY ACTUATORS • SPECIAL CONTROLS

Circle 588 on Inquiry Card

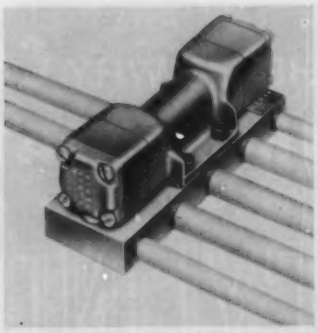
AC Controller

Used for measurement and control of current to ac motors or other ac circuits, electropneumatic controller uses no vacuum tubes or transistors. By measuring current flowing and converting the measurement to a pneumatic signal, all of the advantages of pneumatic instrumentation are obtained.

One application of the controller is in pulverized coal combustion control systems where the current controller regulates the coal input to a bowl pulverizer as needed to maintain the combustion rate. In these systems, an automatic set point controller is used. Integrated into the fuel system, the current controller regulates coal flow from the fuel demand signal. Other installations of the ac controller include motor driven compressors, exhausters, blowers, etc. in which motor drives range from 5 to 10,000 motor hp.

Device can be used to measure single-phase ac in a power line or in one leg of a three-phase motor. It can limit current to a predetermined maximum or it can be used to maintain current at a set point value in a control system. In measurement applications its pneumatic signal can be used with standard pneumatic recording or indicating instruments. When used for current measurement, the pneumatic output is a 0 to 30 psi signal which can be either linear or nonlinear with the load. As a controller, the set point can be established locally by manual adjustment or remotely by pneumatic adjustment. **Hagan Corp.**, Hagan Bldg., Pittsburgh 30, Pa.

Circle 444 on Reply Card

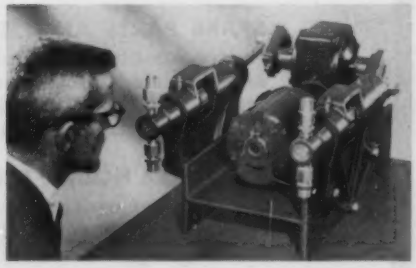


Manifold Mount Valves

Designed for installations where space is at a premium and where speed of removal and reinstallation are required to insure uninterrupted production, line of manifold mount control valves is available in two, three, four and five-way types in sizes from 1/8 to 1-inch NPT. All piping can be installed, connected to the manifold plate, and even purged before installation of the valve itself.

Illustrated manifold valve is a four-way double pilot. Valves are available with any type of actuating device, and for pressures from partial vacuum to 500 psig. Standard manifold plates with threaded porting in either side or bottom are available in rolled aluminum; brass or steel plates are supplied upon request. **Versa Products Co. Inc.**, 249 Scholes St., Brooklyn, N. Y.

Circle 445 on Reply Card

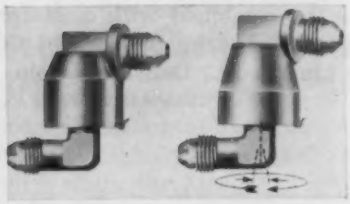


Proportioning Pump

Adaptable to a wide range of chemical feeding applications, Model 1140 proportioning pump features high feeding accuracy, positive feed rate settings, and economy of initial and upkeep costs. Plug-in reagent end and other standardized mechanical components are accessible for easy servicing. Pump also features Vane-Guide check valves with reversible seats, and minimum clearance volume cylinders of self-purging design.

All standard models are equipped with micrometer stroke length adjustment, with in-motion rate adjustment available if desired. Unit will handle feed rates from 0.8 to 900 gph and discharge pressures to 1340 psig. **Proportioneers Inc.**, 345 Harris Ave., Providence, R. I.

Circle 446 on Reply Card

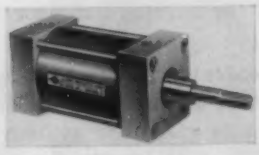


Swivel Joints

Identified as aircraft type swivels, new joints provide safety and flexibility in piping or tubing lines in in-flight equipment, track vehicles and other installations. Two basic types are available with AN flared or Ermeto ends in aluminum, steel and stainless steel for pressure up to 4000 psi. Joints can be furnished either individually or in complete assemblies of joints and tubing for applications in hydraulic, air, oxygen, fuel, steam and acid service, for temperatures from −300 to 700F.

Plane swivel joint permits 360-degree rotation in a single fixed plane with starting torque as low as 5 inch-lb. Double row precision ball bearings afford smooth swiveling under thrust and radial loads. Self-aligning swivel joint has 360-degree rotation plus 15-degree total side flexibility which compensates for misalignment and minimizes binding wear. **Barco Mfg. Co.**, Dept. J 26, 500 Hough St., Barrington, Ill.

Circle 447 on Reply Card



Double-Acting Cylinders

Intended for applications which require accurate register of the

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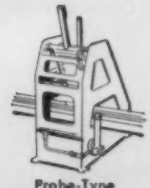
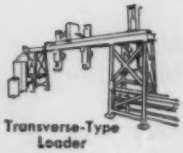
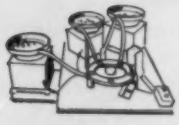


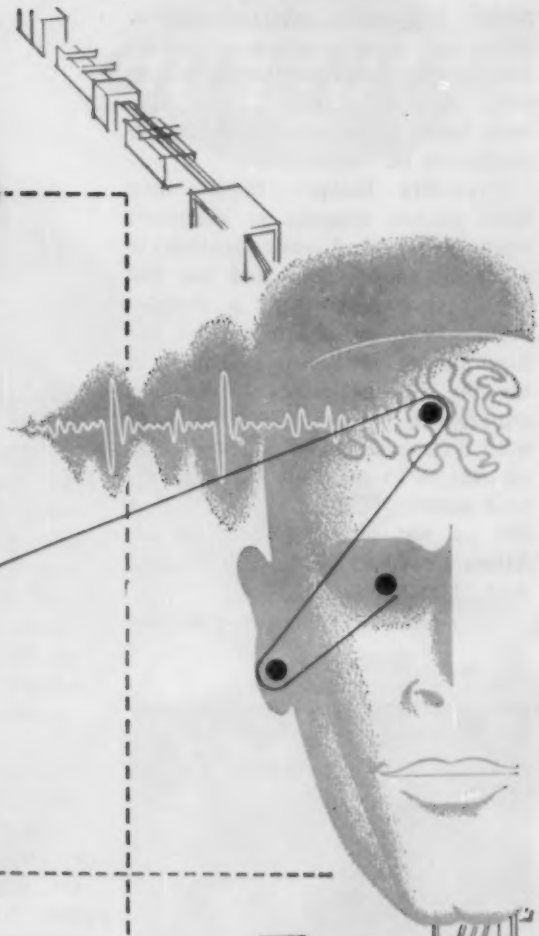
Probe-Type Inspection Machine



Transverse-Type Loader



Metal Fastener Assembly Equipment



Now to better serve your needs and help you solve automation problems quickly, Barnes offers a two-fold coordinated service.

COMPLETE PRODUCTION-LINE ENGINEERING

1 For new production line methods calling for either automatic or semi-automatic operations, you'll find at Barnes an experienced engineering staff to work with you. Detailed plans and proposals will be submitted for your consideration and can be depended upon to give you the latest in automation ideas and the very best of proven mechanical, hydraulic, and electrical actuation methods. Ask for a survey early in your planning program.

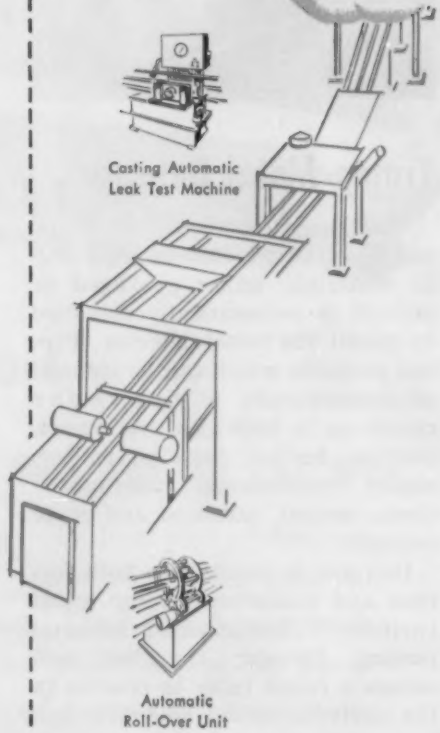
DESIGNING & BUILDING SPECIALIZED UNITS

2 The second and equally important part of Barnes two-fold service is the designing and building of specialized individual units to suit your specific needs. At Barnes you'll find a coordinated service where electrical, mechanical, hydraulic, fixture and tool engineers work together as a team. The combined efforts of a highly skilled and experienced engineering staff, coordinated with complete manufacturing facilities, help you save time by eliminating divided responsibility.

ASK FOR A METHODS ANALYSIS

Find out today why more and more Production Executives are turning to Barnes for a practical solution to their automation problems. We will be pleased to analyze your requirements, offer recommendations, and submit a cost estimate in a formal proposal if you so desire.

Casting Automatic Leak Test Machine



Automatic Roll-Over Unit

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W. F. & JOHN BARNES

AUTOMATION SECTION

414 S. WATER ST. • ROCKFORD, ILLINOIS

SPECIAL MULTIPLE SPINDLE MACHINE TOOLS • SPECIAL PROCESS EQUIPMENT • SPECIAL ELECTRICAL CONTROLS

Circle 589 on Inquiry Card

piston rod with external guides, series of double-acting cylinders has an elliptical nonrotating piston rod. Available in 1¾ and 2½-inch bores, the cylinder is known as Model E.

Cylinders feature three - way flush rabbet mounts as standard equipment. Rod configuration is designed to fill the need for the nonrotating feature in a double-acting cylinder where heavier return thrust is desired. Model E has an elliptical bushing which is adjustable to permit compliance with different rod fit requirements, as well as to compensate for eventual wear. Cylinder is rated at 250 psi air, 500 psi water or oil. **Alkon Products Corp.**, 200 Central Ave., Hawthorne, N.J.

Circle 448 on Reply Card

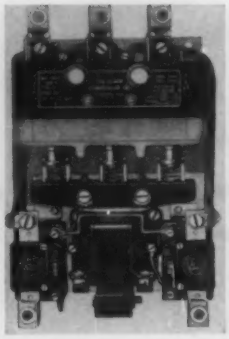
Tramp Metal Detector

The presence of unwanted tramp metal particles hidden in nonmetallic materials, either packaged or in bulk is automatically signalled by Model TM metal detector. Typical products which can be inspected automatically at conveyor speeds up to 1000 fpm are: Foods, plastics, lumber, textiles, rubber, paper, confections, pharmaceuticals, cement, ceramics and stone products.

Detector is sensitive to both ferrous and nonferrous tramp metal particles. Contaminated material passing through the test coil causes a reject relay to operate in the electronic unit. This relay can be used to sound a warning gong, trigger a marking device or operate reject gate.

Inspection apertures can be made any convenient size and may be mounted in any position to permit passage of the product. **J. W. Dice Co.**, Englewood, N.J.

Circle 449 on Reply Card



Magnetic Starter

Addition to line of CY starters is a Size 4 ac magnetic unit. Vertical lift unit features ruggedness and ease of maintenance. All maintenance and inspection, including removal and replacement of components, can be accomplished from the front without special tools, and without removing the starter from its panel or enclosure.

Starters utilize a combination of twin-break contacts and multiturn magnetic blowouts. Magnetic coils around each stationary contact either lengthen or compress the arc, depending on direction of current flow at time of interruption, and cause the arc to rotate. Thus the arc does not remain at the same point on the contacts. The constantly moving arc distributes the effects of arcing over the entire surface of both contacts, minimizing pitting, burning and erosion, thus extending contact life. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, O.

Circle 450 on Reply Card

Control Switch

Used in automated production machinery, machine tools, printing presses, packaging machinery, paper mill equipment, etc., push-button control switch is designed for applications in both the original equipment and replacement markets. Rated at 600v ac or dc, unit is dust, oil and water-tight.

Built to mount in 1 13/64-inch diameter holes on standard panel mounting centers, the Gold-N-Ring switch will accommodate panel thicknesses from 1/16 to ¼-inch in increments of 1/32-inch. Interchangeability of units and their components provides for flexibility and ready adaptation to multiple assemblies. Switches can be obtained in flush plate or box type mountings to permit any combination of individual pushbutton, selector or pilot light assemblies. **Electrical Mfg. Div., National Acme Co.**, 170 E. 131st St., Cleveland 8, O.

Circle 451 on Reply Card

Impulse Monitor

Safety shutoff and alarm for automatically controlled processes which requires no sensing elements or electronic circuity is called the Impulse Monitor. Device provides a complete shutdown of the process and sounds an alarm in the event of controller failure in the *On* period; an alarm is also sounded in the event of abnormal *Off* period or fusing of the power contactor.

Impulse Monitor can be applied to any process involving heat, pressure or flow where the control system uses an *On-Off*, two-position or pulsing type of control mode and where the input is of reasonably uniform duration. Absence of sensing elements such as thermocouples and thermal bulbs and of electronic circuitry assures positive, dependable operation with no possibility of failure from added

PRODUCTION MACHINERY

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TODAY A BIG, TOUGH JOB FOR PRODUCTION

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Automobiles . . . airplanes . . . farm machinery . . . appliances. Whatever your product may be, the baffling problems of new model production have a way of disappearing when you invite Greenlee engineers to participate in your planning. These men have a knack (nurtured by long experience) for translating design into profitable, low-cost manufacturing. Their thinking is sound . . . creative . . . respected in many industries. Write or phone for a consultation today. It will pay you to investigate.

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- Transfer-Type Processing Machines
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- Hydro-Borer Precision Boring Machines

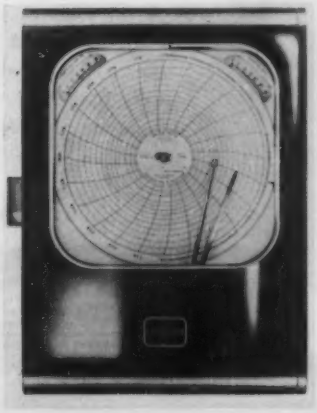
PRODUCTION MACHINERY GREENLEE

GREENLEE BROS. & CO.
2092 Mason Ave.
Rockford, Illinois

Circle 590 on Inquiry Card

components. Operation of the unit is a direct function of the signal from the automatic controller. A toggle switch permits bypassing the monitor during the initial process rise and during erratic changing of the process. **Damol Corp.**, 541 Land Title Bldg., Philadelphia 10, Pa.

Circle 452 on Reply Card



Air Controller

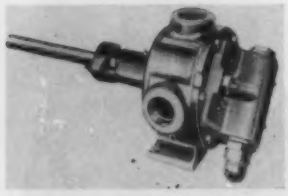
Offered for measuring and controlling such variables as pressure, vacuum, temperature, liquid level, flow, differential pressure and mechanical motion, Series 500 air controller features high stability of control action without loss of sensitivity, coupled with a wide proportional band.

Control modes available include narrow band (*On-Off*), proportional, reset, derivative, and reset plus derivative. Cascade, selective and ratio control modes are also available, as well as program control models. Among design features of the controller are wide proportional band width with easy shift in width, full zero derivative setting on triple model controller, reset action stops for prolonged deviation from set point under severe load changes, easy reversal of action and a precision linkage arrangement allowing complete disassembly and recalibration with only one adjustment. **Bristol Co.**, Waterbury 20, Conn.

Circle 453 on Reply Card

Rotary Pumps

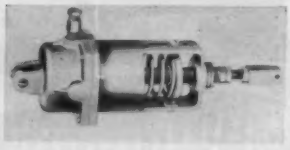
Designed to handle liquids of light to medium viscosities at pressures to 125 psi, illustrated Series



A model internal gear rotary pump is one of five types in new line. All models have circular tooth design in their rotors and idlers, providing rolling contact and smooth engagement of teeth, thus resulting in a reduction of friction and in high volumetric efficiency.

Series A standard duty pumps consist of 10 basic sizes from 3 to over 100 gpm maximum capacities in two speed ranges up to maximums of 650 and 1800 rpm. Other models are designed for handling hazardous liquids, for bulk station uses, for handling volatile substances and for asphalt and other materials of medium to high viscosities. **Wayne Pump Co.**, 120 Tecumseh St., Fort Wayne, Ind.

Circle 454 on Reply Card



Diaphragm Motors

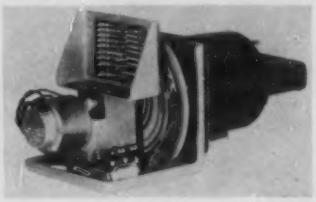
Air, water, or oil pressure can be used to power three gradual acting Powerstroke diaphragm motors which are intended for gradual push-pull control of levers or rods on industrial equipment, as well as for heating, ventilating and air conditioning control. Motors permit an infinite number of shaft positions through the stroke range. Sizes available include 3, 4, and 6-inch, with respective thrusts of 80, 235 and 500 lb, and maximum strokes of 2⅛, 3 and 4⅛ inches.

In operation, air or hydraulic pressure on the molded neoprene diaphragm advances the spring-loaded piston. When pressure is relieved, the spring returns the piston to its starting position. Hesitation spring feature on all three motor sizes permits their use where a mid-stroke pause is desired. **Powers Regulator Co.**, 3434 Oakton St., Skokie, Ill.

Circle 455 on Reply Card

Data Converter

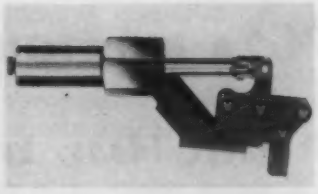
Designed for accurate long distance transmission of data representing voltage, current and power, analog to digital converter is not subject to varying line conditions and resultant inaccuracies of readings. Converter assures accurate transmission of digitized readings under conditions of drift, temperature and voltage effect. Device is a photo scanner which



converts an analog meter indication into digital form for serial or parallel long distance transmission. The converter uses a pointer type meter without modification of the movement or loading of the output shaft.

Basic elements of the meter reader are: Photocell and light source assembly, pointer path length mirror, small motor, code disk, sensitive relay, and a group of digit storage relays—one for each digit of the code disk. **Pacific Div., Bendix Aviation Corp.**, 11600 Sherman Way, N. Hollywood, Calif.

Circle 456 on Reply Card



Cylinder Clamp

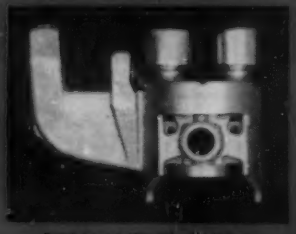
Designated Triple-E 700-A, cylinder clamp can be operated by hooking into either an air or hydraulic line. A clevis connects the cylinder to the clamp, allowing the cylinder rod to travel in a straight line, even when there are angular thrusts on the clamping bar.

All components of the clamp are of solid bar stock to insure maximum strength. Pivot points have broach fit hardened bushings to provide long operating life. Clamp

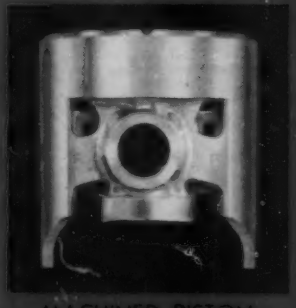
La Salle dial-inline-amatic

New Automated Piston Line

a dial type machine and an in-line type machine combined to form a single fully automatic unit!



PERMANENT MOLD



MACHINED PISTON

fully automated 14-station unit

The pistons, as they come from the mold, are fed, on conveyor, directly to this new unit. They pass thru 5 stations in the "Dial Type" section, and 9 stations in the "In-Line Type" section of the machine. And, the pistons are never slid, rolled or bumped.

series of operations performed

It mills off the gates and risers; pierces the wrist pin hole, and the window around the wrist pin hole; hollow mills the piston OD; faces the piston head; faces, and chamfers the skirt of the piston; weighs, and gages each piston; and, rejects pistons found to be over size, over weight, under size or under weight.

produces 400 pistons per hour

Furthermore, this unit will handle, any one of 3 different pistons, merely by changing the position of the selector switch, and the fixture locaters.

maximum flexibility for model changes

The shuttle mechanism can be adjusted for different size and shaped pistons, which automatically allows for future parts design changes.

unitized construction

It's built to J.I.C. Hydraulic and Electrical standards. There's automatic lubrication throughout. And, there is a chip conveyor provided in the base of the unit.

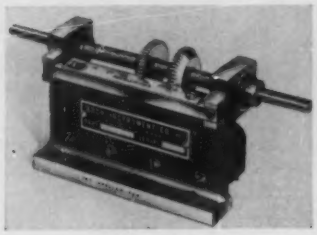
La Salle tool, inc.

ENGINEERING & BUILDING SPECIAL MACHINERY

3840 EAST OUTER DRIVE • DETROIT 34, MICHIGAN

is powered by a noncorrosive cylinder. End covers, tube and piston are made of brass. The piston rod is hard chrome plated; all components are oil impervious. **E & E Engineering Inc.,** 15023 Harper Ave., Detroit 24, Mich.

Circle 457 on Reply Card



Limit Switch

Rapid, precise adjustment to close operating tolerances, and good repeatability in high or low-speed operation are features of limit switch designated Model LS-1. Exact limitation of rotary motion is assured by the use of two cams that are driven along a rotating lead screw to actuate two single-pole double-throw precision snap-acting switches. The lead screw is connected to the system to be controlled by suitable gears. Adjustability of one part in 3400 and repeatability of ± 5 degrees of a 360-degree revolution of the lead screw are features of the unit; limit of travel for the cams is from one to 70 turns of the lead screw.

Limits are quickly and accurately set by pulling the calibrated scale bar forward to disengage the teeth on the perimeter of the cams, rotating the cams on the lead screw to the desired limits, and allowing the scale bar to spring back to its original position. Cam settings are read directly on the scale bar, which is calibrated in revolutions of lead screw, and is conveniently placed for visibility and use. **Arch Instrument Co. Inc.,** 101 Holmes St., N. Quincy, Mass.

Circle 458 on Reply Card

Scale Indicator

Semi-null balance indicator, used with Atcotran differential transformers, resistance bulb and thermistor inputs, provides a compact, easily-read instrument. The semi-null balance circuit minimizes

voltage variation and does not require the use of line voltage stabilizing devices. A fail-safe feature permits the pointer to drop to zero when the current fails or when the differential transformer circuit opens up.

Scale can be equipped with a dual secondary transformer for operation of 4-LO control settings by combining with zero adjusts and a control relay. It can also be fed into a secondary indicator. Linearity is $\pm \frac{1}{2}$ per cent and repeatability is $\pm \frac{1}{2}$ per cent or better. **Automatic Temperature Control Co. Inc.,** 5200 Pulaski Ave., Philadelphia 44, Pa.

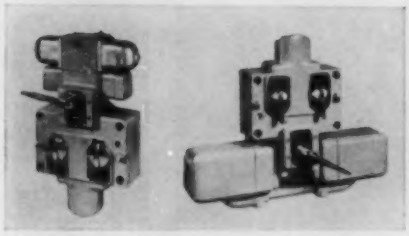
Circle 459 on Reply Card

Temperature Controller

Accurate *On-Off* temperature control of heating operations, processes, equipment; safety alarms and cutouts on similar installations; and combinations of control and alarm are applications of series of temperature controllers. Called Models F-1C, F-2C, and F-3C, the series features a choice of one, two or three snap action switches on any instrument to make many installations possible. Temperatures from subzero to 2000F can be handled without difficulty; adjustable ranges as wide as 1200 degrees in one instrument are offered.

Operation is by the difference in expansion of two concentric tubes when exposed to heat. The resulting movement is multiplied through a lever arrangement which actuates one or more switches. Standard switch rating is 15 amp, 125-250v ac, with higher ratings available. **Burling Instrument Co.**, 16 River Rd., Chatham, N. J.

Circle 460 on Reply Card



Traverse & Feed Panels

Used for the control of industrial oil-hydraulic systems, subplate mounted traverse and feed panels are well suited for application on a variety of machine tool and production equipment, such as that used for drilling, reaming, boring, turning, milling, swaging and grinding machinery. All three series, designated, CPP, CPN and CPD, feature improved valve sections for direction and feed control. Each is available in a wide selection of models to meet the full range of industrial hydraulic systems requirements. They are designed for use with ¾-inch nominal pipe size. Maximum recommended operating pressure is 1000 psi.

Conventional or differential cylinder traverse action models are available. Differential models are used with cylinders having a rod area equal to approximately one-half the piston area for obtaining fast traverse rates with smaller pumps in certain installations. All models are available in inverted designs where it is necessary to have the roller attached to the main spool extending downward.

Redesigned flow control valve section in the traverse and feed

FOR CUSTOMIZED CONVEYORS WITH MAY-FRAN STANDARDIZATION

Developed to provide the ultimate of versatility, the May-Fran program of STANDARDIZATION permits users to create and construct their own conveyors to meet individual needs.

It literally provides a type of "super market" shopping for the straight, curved, inclined, take-up and discharge end sections required to meet the specifications of YOUR job requirements. Sections can be furnished to meet belt width as well as load bearing and volume capacities. Conveyors can be changed relative to length or width with only a minimum of downtime.

Write today . . . ask for a copy of MF Bulletin No. 200

MAY-FRAN ENGINEERING, INC.
1761 Clarkstone Rd. • Cleveland 12, Ohio

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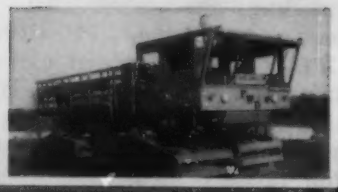
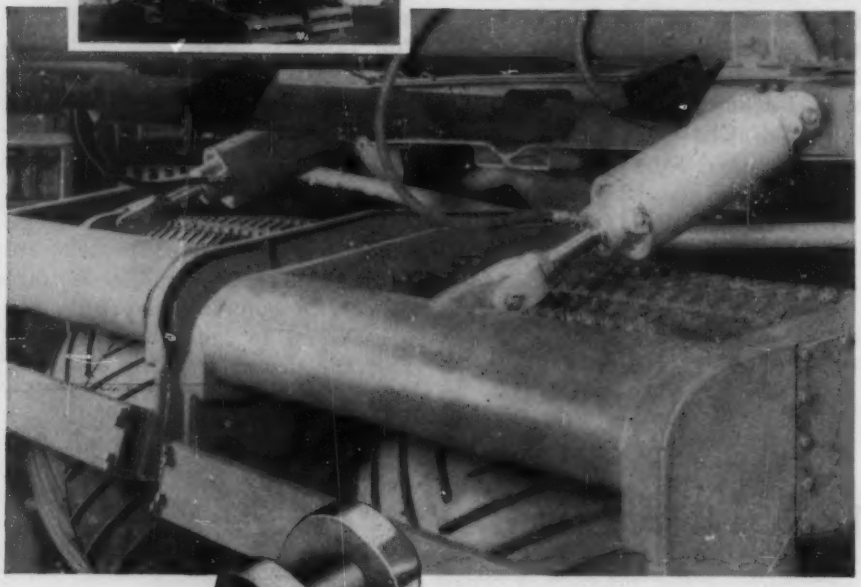
Circle 592 on Inquiry Card

Arctic Cargo Carrier Depends On T-J Spacemaker CYLINDERS

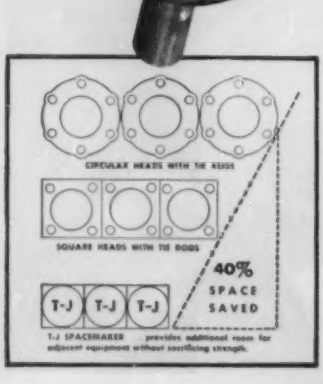




Saves 40% Space
No Tie Rods...
Greater Strength

Differential axle loading through T-J Spacemaker Air Cylinders forms a controlled walking beam in this Tera-cruiser, designed and produced for the Army Ordnance Corps by the Four Wheel Drive Co., Clintonville, Wis.

Weight of cylinders was important factor in choosing T-J Spacemakers, which reduce weight while providing same displacement and extra high safety factor. Fast delivery and space-saving features also favored T-J. Exclusive with T-J are new Super Cushion Flexible Seals for Air (to 200 P.S.I.) . . . and New Self-Aligning Master Cushion for Oil (to 750 P.S.I.). Hard chrome plated bodies and piston rods are standard, at no extra cost. Wide range of styles, capacities . . . 64,000 combinations *off the shelf!* Write for bulletin SM-155-3. The Tomkins-Johnson Co., Jackson, Mich.



MEETS WITH ALL JIC RECOMMENDATIONS

T-J TOMKINS-JOHNSON
DIVITORS . AIR AND HYDRAULIC CYLINDERS . CUTTERS . CLINCHORS

panels includes two locking type dials which permit independent selection of both fine and coarse feed rates. Adjustment is infinitely variable within the specified range and can be made during feeding operation. **Vickers Inc.,** Box 302, Detroit 32, Mich.

Circle 461 on Reply Card

Thermostatic Controller

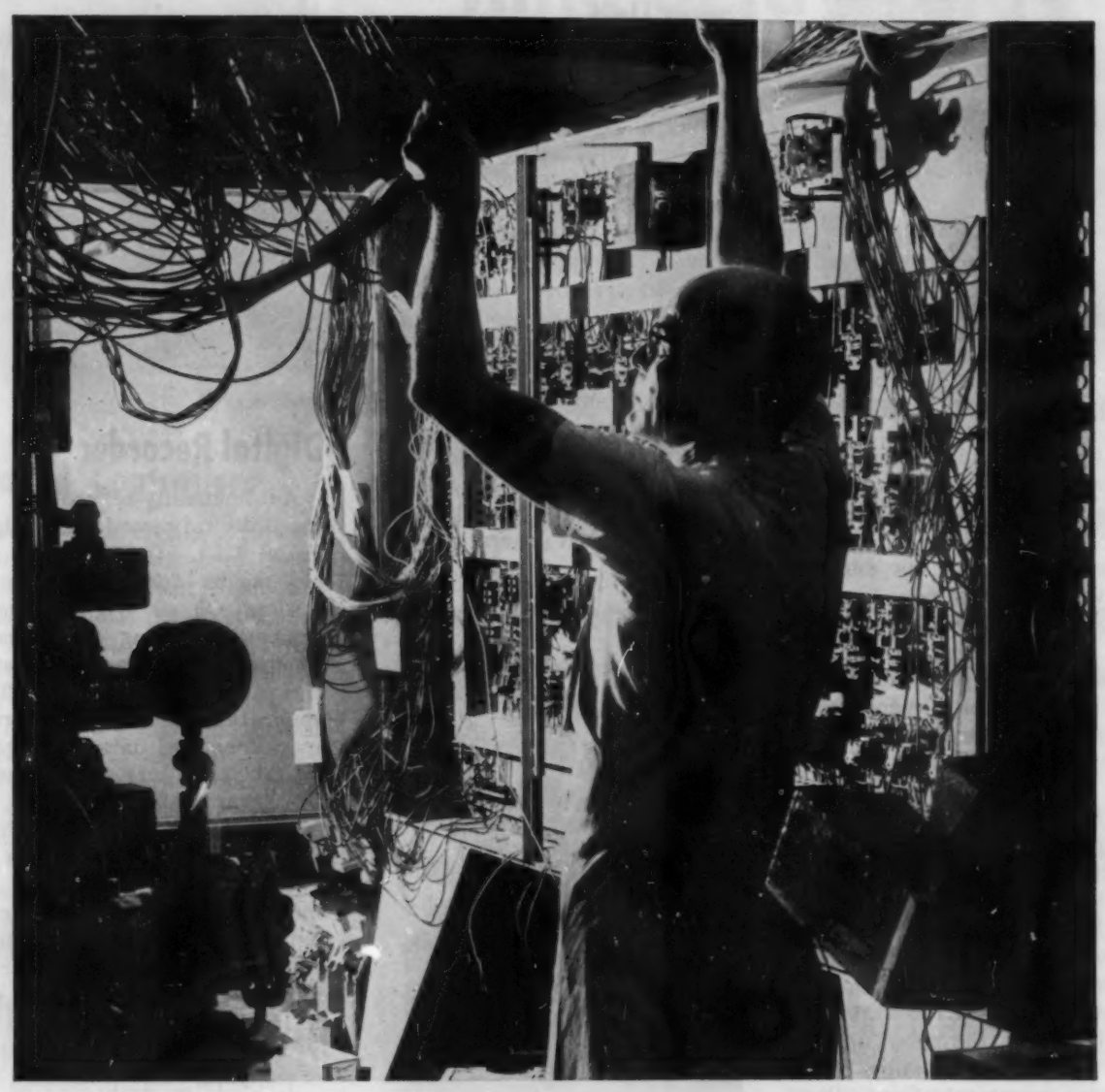
Designed to provide accurate temperature regulation of liquids or air when used in conjunction with valves, dampers or other controls, pilot type thermostatic controller is employed in control systems of electroplating tanks, dyeing and bleaching machinery, chemical vats and processes and other applications in which rapid response and adjustable control characteristics are required. Model 1100C,D is used for high temperature applications and is available in standard temperature ranges of 250 to 450F, and 350 to 550F. Control is recommended for use where compressed air is used as the pilot supply.

Thermosensitive tube is made of stainless steel to withstand corrosion as well as temperature and erosion. A finned thermal isolator section keeps the pilot valve, etc., cool on the high-temperature control applications. Called the FulTrol, the pilot controller is installed at a location where temperature is to be maintained. The instrument's sensitive rod-and-tube thermal element is immersed directly into the medium being controlled. Any change in temperature at the thermal element activates a small pilot valve, which in turn varies the pressure applied to a control valve or other final regulating device. Operation of the final control device governs the amount of either cooling or heating applied to the medium under control. **Fulton Sylphon Div., Robertshaw-Fulton Controls Co.,** Box 400, Knoxville, Tenn.

Circle 462 on Reply Card

Circle 593 on Inquiry Card

Operation *AUTOMETROLOGY



The central nervous system goes into an automatic gaging machine which will soon allow an antifriction bearing manufacturer to make significant production savings. To be specific it will:

- **Eliminate the need in the assembly area of a large inventory of bearing parts and the space that inventory occupied.**
- **Materially reduce the percentage of scrap.**
- **Greatly increase the production rate of dimensionally acceptable bearings.**

This and all other automation projects are handled by Sheffield's Research Division. Sheffield has the over-all experience and the skilled technicians to make automation productive for you. Let Sheffield engineers help plan your automation project. Call the Sheffield Corporation, Dayton 1, Ohio, U.S.A., Dept. 3.

* AUTOMETROLOGY←*The science of automatic gaging and dimensional classification—also the control of production machines to hold product within prescribed dimensional limits.*

MASTER CRAFTSMAN GOLDEN ANNIVERSARY HEADQUARTERS

SHEFFIELD

manufacture and measurement for mankind

7429

Circle 594 on Inquiry Card

Tension & Speed Control

Used for the winding and feeding of paper, textiles, metal strip and webs, and tapes of all kinds, Dancetrol unit provides automatic tension control from a few ounces up to several hundred pounds, and constant velocity control to several hundred fpm. It can be adapted to dancer rolls or pivot arms on existing machines or incorporated as part of a new machine. It may be mounted on the frame of the machine or is available with its own adjustable stand for floor mounting (illustrated).

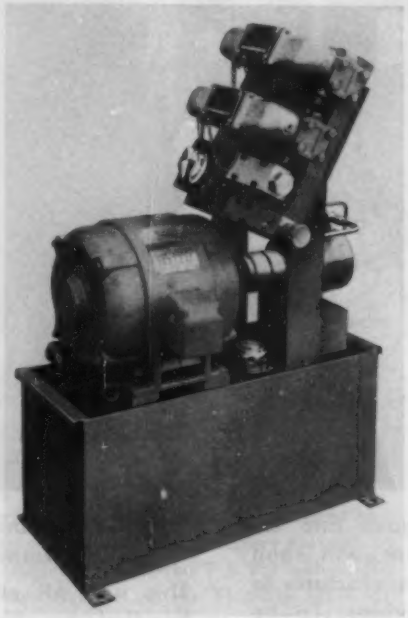
Two types are available. The limit switch type provides *On-Off* control for drive motors or for pilot motor control of variable speed drives. The proportional type provides control for variable speed drives with the speed-up or slow-down signal proportional to pivot arm movement from the neutral position. For mechanical variable speed drives a balanced bridge follow-up control is used.

One typical application uses a stand mounted unit providing constant velocity feed control to a punch press. The Dancetrol cams are set so that under normal operation the intermittent feed required by the press does not actuate either limit switch. The variable speed feed drive operates continuously with the feed loop building up and then being almost completely absorbed. As the feed roll diameter decreases the dancer approaches the upper limit as the press absorbs the loop. Upper limit switch then closes the speed-up circuit of the pilot motor on the variable speed feed drive. **Jordan Co. Inc.**, 3235 W. Hampton Ave., Milwaukee 9, Wis.

Circle 463 on Reply Card

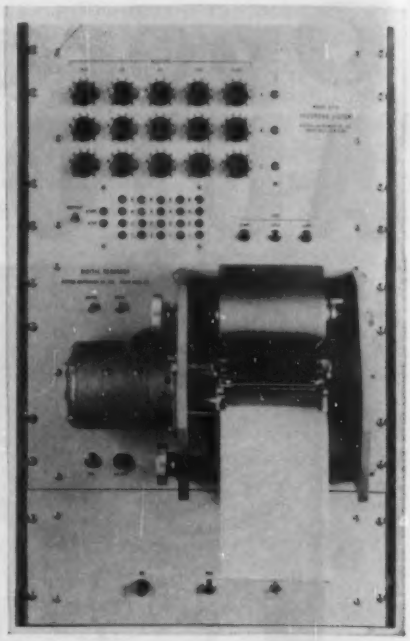
Power Unit

Available with a complete circuit to supply automatic feed and traverse action in automated machine tool setups, power unit has a pressure compensated pump with flow control features. Basic unit, called the ST-10, has a capacity of 5 gpm at 2000 psi. It is comprised of a 10-gal reservoir and fittings (breather, cap and screen, gage, baffles, etc.), a 3 hp electric motor, and a pressure compensated variable displacement pump and relief valve. Pump automatically reduces the oil volume pumped when little work is being performed, yet maintains full required circuit pressure, thus stopping heat generation within the unit.



Variable volume control is available to allow various maximum volume settings, preventing waste of power. Adapting the unit to feed and traverse jobs, such as in milling, drilling or pressing operations, is done by using one of two available circuits, one of which produces higher traverse speeds by powering a 2 to 1 cylinder. **Rosaen Co.**, 1756 E. Nine Mile Rd., Hazel Park, Mich.

Circle 464 on Reply Card



Digital Recorder

Automatically-sequenced, high-speed digital recorder is designated Model 3151. Unit provides a simple means for simultaneous recording *On* or *Off* voltage phenomena appearing on as many as 45 channels at sampling rates as high as 2500 per second. Typical applications include monitoring of operations and data in large-scale digital computers and other data processing systems.

Records are made in the form of black marks for *On* channels (positive voltage input of lv or more) and no marks for *Off* channels (no signal input) on electrosensitive Teledeltos recording paper. Recording paper speed is in excess of 150 ips, providing approximately 1/16-inch spacing for the 2.5 kc sampling rate. Standard 4-inch wide paper rolls contain 400 ft of recording paper, providing more than 3,500,000 record locations on a single roll.

Because of the high speed paper drive mechanism, a three-sequence digital interval generator is used to program paper drive functions. Each sequence is adjustable from 1 to 99,999 milliseconds in 1 millisecond steps, using the self-contained crystal controlled time base oscillator. During the initial sequence, the recording medium remains at rest. The second sequence is adjusted to allow the paper to come up to full speed just prior to the desired recording

start time. The third or recording sequence is adjusted to be just long enough to record the selected data. The system may be automatically reset to the first sequence at the completion of the third cyclic operation. **Potter Instrument Co.**, 115 Cutter Mill Rd., Great Neck, N. Y.

Circle 465 on Reply Card

Packaged Controllers

Providing automatic, flexible monitoring and control of most chemical or mechanical conditions that can be measured electrically, line of industrial controls is available with both high and low limits. Among the functions that can be controlled by the instruments are voltage, current, torque, timing, pressure, temperature, liquid level, speed, depth, light, sound and deflection. Controls are effective over a variety of ranges for each function.

Controls are of the indicating type, calibrated in whatever units are applicable. One pointer on the unit gives a continual reading of the signal from the operation being monitored; a second pointer may be turned to any place on the dial—usually a 95-degree scale arc—to fix the allowable signal limit. Depending on the circuitry, the units will initiate desired control action when either an increasing or a decreasing signal reaches a preset point. Sensitivities begin with 0 to 5 microamperes or 0 to 5 mv.

Either *On-Off* or locking control action may be selected on most units. Controls are available in either single or multimeter models, depending on whether one or several signals must be monitored to provide complete control. **Tipp Mfg. Co.**, Tipp City, O.

Circle 466 on Reply Card

NEW HAGEN
hand set
time delay relay

Foolproof on Repeat Settings

No danger of over-timing when you repeat a process several times — each with the same timing. On the first run, operator simply presses the stop release button and sets the adjustable stop (both shown in blue) at the desired time . . . then turns the pointer as far to the right as it will go . . . it can't go beyond the stop. Thus the setting is always correct — on the first and all subsequent runs.

A synchronous motor returns the cam shaft to "O" position, tripping switches in accordance with time settings. The process is stopped automatically.

A wide selection of snap-action switches is available . . . as well as cam combinations. The Hagen Hand Set Time Delay Relay Model 73 is the answer to controlling solenoid valves in an industrial process, starting a group of motors in sequence, for pump controls, and many other uses.

Send for Bulletin 580

MAIL COUPON TODAY!

HAGEN MANUFACTURING COMPANY, INC.
Dept. A-1256, Moline, Illinois

Please send Bulletin 580 on the new Hagen Hand Set Time Delay Relay.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

Circle 595 on Inquiry Card

over 8,000 Different Cylinder SELECTIONS—

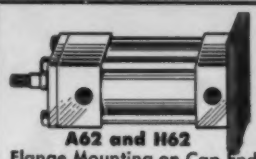
Miller AIR AND HYDRAULIC CYLINDERS AND BOOSTERS "IN STOCK" for immediate delivery

See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

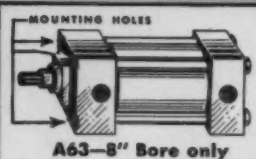
"IN-STOCK" MODELS

"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.

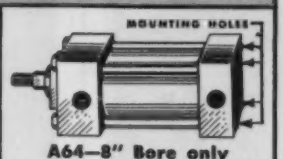
A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)



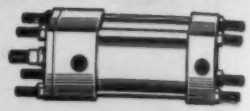
A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)



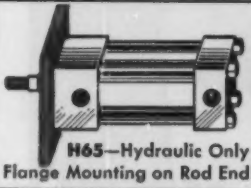
A63—8" Bore only
Flange Mounting on Rod End



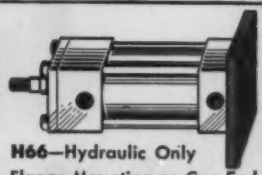
A64—8" Bore only
Flange Mounting on Cap End



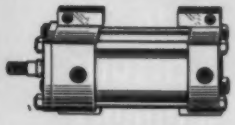
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



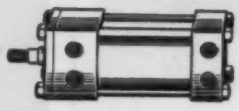
H65—Hydraulic Only
Flange Mounting on Rod End



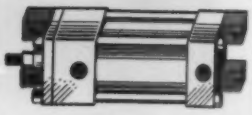
H66—Hydraulic Only
Flange Mounting on Cap End



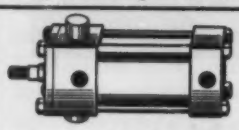
A72 and H72
Side Lug Mounting



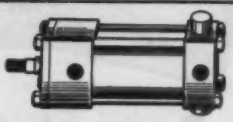
A74 and H74
Side Flush Mounting



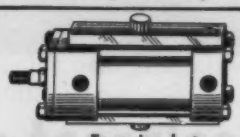
A77 and H77
Side or Foot Mounting



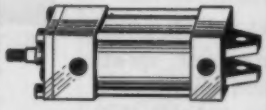
A81 and H81 Trunnion Mounting on Rod End



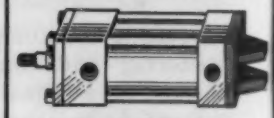
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap (one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES In Inches

"IN-STOCK" STROKES (in Inches)

	BORES	ROD DIA.	ROD TURN DOWN & THREADS		STROKES
AIR	1½	⅝"	7/16-20	Cushioned	3 4 5 6 7 8 9 10 11 12
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12
	2	⅝"	7/16-20	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	2½	⅝"	7/16-20	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	3¼	1"	¾-16	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	4	1"	¾-16	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	5	1"	¾-16	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	6	1⅜"	1-14	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	8	1⅜"	1-14	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned	3 4 5 6 7 8 9 10 11 12
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12
	2	1"	¾-16	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	2½	1"	¾-16	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	3¼	1⅜"	1-14	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	4	1¾"	1¼-12	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
	5	2"	1½-12	Cushioned	3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36
				Non-Cush.	1 2 3 4 5 6 7 8 9 10 11 12 14 16 18 20 22 24 28 32 36

(1) "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

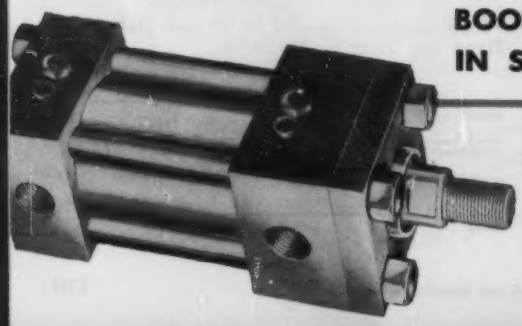
Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.



BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.

Write For Catalog and Stock Price List

Miller

MILLER FLUID POWER DIVISION FLICK-REEDY CORP.

2015 N. Hawthorne Ave., Melrose Park, Ill.

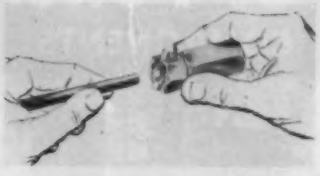
AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

Digital Voltohmmeter

Available in both portable and rack mount models, three-digit instrument is designated Model 352 digital voltohmmeter. Numerical readout can be read from 30 ft or more, from straight-on or at angles.

Accuracy provided is: Dc, ±0.1 per cent; ac, ±2 per cent of full scale from 30 cps to 3 magacycles for voltages greater than lv; ohms ±(0.1 per cent of value read plus 1 digit). Instrument offers following manually selected ranges: Ac, 0.01 to 999; dc, 0.001 to 999; and ohms, 1 ohm to 9.99 megohms. Short balance time of 1 second permits high readout and printing rates. Printer connection and automatic printer controls are available for use with parallel entry data printers. **Non-Linear Systems Inc.,** Del Mar Airport, Del Mar, Calif.

Circle 467 on Reply Card



Tube Plug & Connector

Self-sealing, automatic locking, push on—pull off tube plug and connector provides a fast method of attaching pressure and vacuum lines to straight end tubing. Unit is well suited for production and maintenance applications involving pressure or vacuum testing, because it permits instantaneous, leak-proof connection of the element under test to the vacuum or pressure source without the use of tools, threading, soldering or brazing. Connector is also applicable wherever pressure and vacuum lines are used, such as on heat exchangers, refrigeration units, tube assembly, etc.

To attach the connector, it is pushed over the end of the tubing into the stop position. This operation automatically locks the tubing into place in a leak-proof seal, ready for vacuum exhausting or pressure filling. Connector is designed to operate at any pressure to 1000 psi and any vacuum to 25 microns. It is available in three standard sizes: For ¼, 5/16 and ⅜-inch OD tubing. **Mechanical Products Corp.,** 168 N. Ogden Ave., Chicago, Ill.

Circle 468 on Reply Card

Conveyor Lubricators

Four fundamental improvements are included in 100 Series conveyor lubricators. (1) Mechanism is completely enclosed in a nonporous aluminum housing that provides for economy of space. (2) Improved Crown filters and regulators are standard equipment. (3) Redesigned trip mechanism in the lubricators actuates a Hunt valve through a cam. (4) Provision is made for easy put-in and take-out of service.

Conveyor lubricator series consists of three types of lubricators: Oil lubricators for trolleys and chains, oil lubricators for bearings on slat type conveyors, oil lubricators for hot zone applications. **J. N. Fauver Co. Inc.,** 51 W. Hancock, Detroit 1, Mich.

Circle 469 on Reply Card

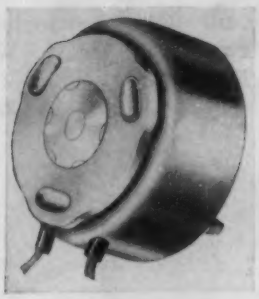
Hydraulic Control Unit

Used in aircraft controls, operating tables, machine tools, folding and packaging machinery, bin and door openers and closers, hoists, testing equipment, construction, mining, marine and automotive equipment, Powerpak unit consists of an electric motor; a high-pressure, low-volume pump; couplings; integral reservoir; automatic valving for cylinder actuation; optional pressure switch and mounting bracket.

Compact unit measures less than 9 inches in height, 6 inches in length and 4½-inches in width. It requires no mounting base and may be mounted in horizontal or vertical position. In vertical mounting position, the pump may be inclined as much as 45 degrees in any direction from vertical, even while operating. Hydraulic device eliminates the need for separate solenoid valves, relief valves and reservoirs. Pressure up to 3000 lb is developed, with 5000 lb peaks. Cylinder actuation is controlled through two oil lines between pump and cylinder. Two internal valvings are available: One locks the cylinder in infinite holding position and the other allows free movement of cylinder except during actuation.

Electrical circuiting allows use of single or duplex switches to limit fluid and pressures. Only electrical connections required are pushbutton switches to actuate forward or reverse motion. **Oil-Dyne Inc.,** 2115E W. Marquette Rd., Chicago 36, Ill.

Circle 470 on Reply Card



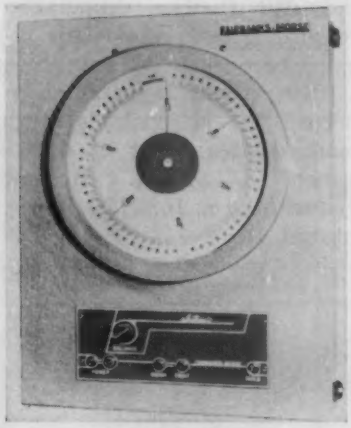
Rotary Solenoids

Smallest of eight basic sizes in line of rotary solenoids, Model BD1E weighs 1½ oz and has a diameter of 1 inch. Starting torques for the line range from the new model's 0.2 inch-lb to 54 inch-lb based on ampere turns for normally intermittent duty cycle and rotary stroke of 45 degrees.

Standard rotary strokes for the solenoid are 25, 35 and 45 degrees, either clockwise or counterclockwise rotation. Voltage requirements of from 2 to 200v dc can be accommodated with coil wire gages ranging from No. 25 to No. 40.

In operation, the magnetic pull moves an armature along the solenoid axis and this linear action is efficiently converted into rotary motion by ball bearings on inclined races. The resulting snap-action power can be harnessed with a minimum of linkages. **G. H. Leland Inc.**, 123 Webster St., Dayton, O.

Circle 471 on Reply Card



Weigh Batching Unit

Line of weighing instruments has been developed to assure accuracy, faster weighing and the convenience of remote weight indication. Two basic types of electronic scales are available: Full electronic in which load cells replace the conventional lever systems and Levetronic in which a conventional lever system is used, but with a load cell hooked in tension in the steelyard rod. The Levetronic system can be used to convert existing full mechanical scales to electronic weighing and instrumentation.

Weight recording instruments may be located as much as 250 ft from the scale platform. Standard instruments include the Model CR which incorporates such features as automatic balance detection, hold or memory circuit, automatic ranging, zero balance knob, net-gross switch, and printer with selective print and weigh buttons. Model C instrument is similar except that it is not furnished with a printer or net-gross switch. Model CW is similar to Model C except that it is furnished for wall mounting.

Model CDO instrument (illustrated) is primarily designed for use where data processing equipment is used. It integrates weights and associated data, thus broaden-

New

SHAKEPROOF®
AUTOMATIC
POWER SCREW DRIVER

- New Model "400" can drive up to 60 hopper-fed screws per minute!
- Ideal for automation as well as conventional mass-production assembly lines!

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SHAKEPROOF / FASTEX — Divisions of Illinois Tool Works

HELLER COP ELECTRONIC COMPONENTS

Self-adjusting DC motor speeds from AC lines!

HELLER ELECTRONIC
Control Of Power
MATCHED COMPONENTS

2T60X
ELECTRONIC CONTROLLER
with matching
1/50 H.P. DC MOTOR

Heller COP Matched Components, installed in original equipment, provide accurate, automatic control of electric power. Thyraton tube-operated 2T60X Controller, shown above, gives stepless operation. • Input: 110-120 V., 60 cy. single phase • Output: 0-120 V., 200 ma. DC to armature • Field constant voltage 110 V. DC • 1/50 H.P. ball bearing, gear head, shunt wound, DC motor. Reversible • Torque constant—0-2200 R.P.M. • Armature shaft is extended • Motors in gear ratios: 6, 18, 30, 100, 300, and 1120:1.

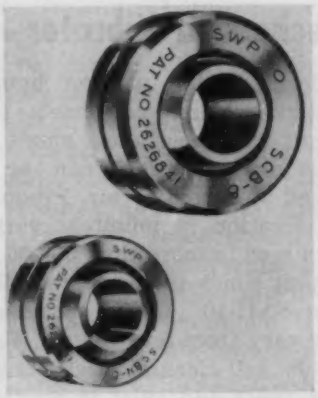
GERALD K. HELLER CO.
1 N. Carey St., Baltimore 23, Md., U. S. A.

Circle 597 on Inquiry Card

Circle 598 on Inquiry Card

ing the scope of work that is performed by all equipment. Model CDO can be connected with such readouts as Digimatic printers, and can be used with such equipment as automatic typewriters, adding machines, teletypewriters, tape punch machines and other automatic business machines. Line also includes two electronic weigh batch control systems. **Fairbanks, Morse & Co.**, 600 S. Michigan Ave., Chicago 5, Ill.

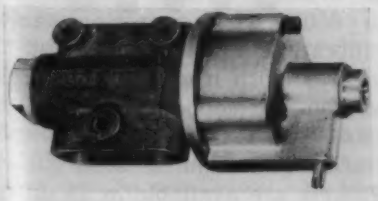
Circle 472 on Reply Card



Self-Aligning Bearings

Line of self-aligning plain spherical bearings is designed for commercial use. Called SCB and SCBN series, the bearings reduce lost motion in linkages and withstand excessive vibration. They carry heavy loads since they have a large surface supporting area. Made of one-piece ball and one-piece race, devices take a high radial and axial thrust load and thus offer long bearing life. Units are available in sizes for 3/16 to 1⅞-inch bore, with capacities of radial ultimate static loads from 3000 to 152,700 lb. **Southwest Products Co.**, 1705 S. Mountain Ave., Duarte, Calif.

Circle 473 on Reply Card



Time Delay Valve

Delayed actuation with immediate reversal or immediate actua-

Chain conveyor handling cylinder liners for tractor engines.

This one is on some of the outstanding conveying systems in the Metalworking Industries

Mathews' Engineers have been designing and building gravity and power conveyers and special conveying machinery for over fifty years, and a great amount of this equipment has been applied in metalworking plants. Mathews' Engineers know the handling problems of the metal producers and fabricators. That's why so many people in these industries have an extra measure of confidence in Mathews equipment—and why you see Mathews Conveyers in metalworking plants everywhere.

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Engineering Offices or Sales Agencies in Principal American and Canadian Cities.
Export Representative—Foreign Trade Division of New York Hanseatic Corp.

Circle 599 on Inquiry Card

UNITIZED WEIGHING

for conveyor systems

Only WEIGHING COMPONENTS offers a packaged unit that:

1. Fits your present or proposed conveyor system with little if any modification.
2. Responds only to vertical weight—not affected by side thrust, load placement or pile-up.
3. Measures rate and/or totalizes.
4. Offers high sensitivity with rugged simplicity.
5. Has automatic tare weight adjustment.
6. Electrical or pneumatic operation—your choice.
7. Use for indicating, recording and/or controlling . . .
8. Highest accuracy — no knife edges, levers or springs.
9. Lifetime construction.
10. Safe for all locations.

Full information available. Send for Bulletin 11.

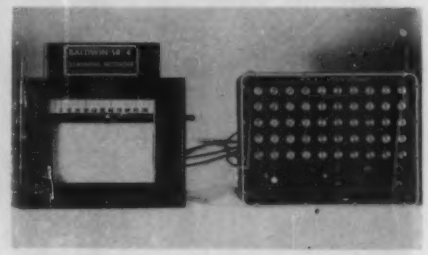
W-C

WEIGHING & CONTROL COMPONENTS, Inc.
206-C Lincoln Ave., Hatboro, Pa.
Circle 600 on Inquiry Card

tion and delayed reversal are provided by two, three and four-way time delay valves. Working on a volume principle, operating time of from 0 to 5 minutes delay may be accomplished by a manual preset adjustment.

Being pilot operated, the valves may be remotely located and controlled from a central station. Valves are available in standard pipe sizes of ¼, ⅜, ½, and ¾-inch. **Airmatic Valve Inc.,** 7313 Associate Ave., Cleveland 9, O.

Circle 474 on Reply Card



Scanning Recorders

Used with SR-4 strain gages, 50-point automatic scanning recorders feature improved design. Either two or four-arm strain gage bridges can be accommodated by proper positioning of a selector switch. A fourth range of 0 to 1000 microinches has been added to ranges of 0 to 2000, 0 to 5000 and 0 to 10,000 microinches. Individual stress-strain curves can be plotted automatically for each channel, making unnecessary the plotting of points in order to analyze test results, and permitting immediate information on possible structure failure, while the test is in progress. This is accomplished by an automatic advance of the chart in increments of 4 inches for any given percentage of ordinate reading. Stress-strain curves are plotted on scales of 0 to 100 for strain and 0 to 100 per cent for load. After each complete sequence of readings the chart is advanced manually by a proportional amount of the full load on the stress axis.

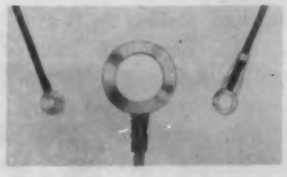
To conserve chart paper when less than 50 channels are being scanned, a chart skipping mechanism is provided. Completion of a sequence of 50 readings requires 30 to 90 seconds. Instrument has manual adjusting knobs for gages with resistances ranging from 60 to 500 ohm and gage factors beween 1.77 and 2.25. **Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.,** 806 Massachusetts Ave., Cambridge 39, Mass.

Circle 475 on Reply Card

Mechanical Vibrator

Designed for use on hoppers, feeders, molds, gage panels, packaging machines, etc., small size mechanical vibrator can be operated on steam or air. Frequency of vibration is infinitely variable from zero to more than 50,000 cpm on unit which is designated Vibrolator SAH-10. Operating pressure may vary from 5 to 150 psi. Vibrator is self-cleaning, self-starting, sparkproof and quiet in operation. **Martin Engineering Co.,** Neponset, Ill.

Circle 476 on Reply Card



Gasket Thermocouples

Originally designed for use beneath spark plugs of internal combustion engines, gasket thermocouples are now used to measure skin temperatures in chemical and food processing, metalworking, atomic energy and many other industries. Gasket thermocouples are available in three ranges: −300 to 600F with copper-constantan calibration and copper gasket, 75 to 900F with iron-constantan calibration and copper gasket, 900 to 1200F with iron-constantan calibration and stainless steel gasket. Gaskets are available in 14 different hole sizes from 5/32 to 1 1/16-inch ID, and also 10, 14 and 18 mm diameters. **Thermo Electric Co. Inc.,** Saddle Brook, N. J.

Circle 477 on Reply Card

Speed Controller

Designed for applications where accurate speed control is required over a wide range with automatic response to a control signal, air control system is used for high accuracy, fractional horsepower variable speed drives. Control can be used on drives delivering speeds from any desired maximum down to zero and, if desired, reverse. Illustrated model is a ¼-hp unit with pneumatic operator, built-in helical spur reducer and built-in single-phase, explosion proof motor.

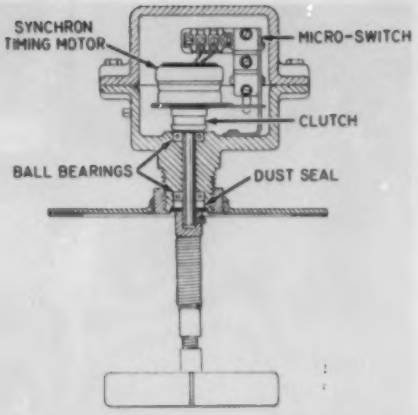
Pneumatic control operates on a 3 to 15 psi signal with control signal originating from liquid level, pressure or flow rate devices or a variety of other transducers. Control signal may also be transmitted from pneumatic recorders or recorder controllers. Normally zero speed is obtained at a control pressure of 3 psi with maximum speed at 15 psi. Transmission is available with a variety of built-in reducers including spur and worm reduction types with output shaft horizontal or vertical. Built-in motors of all types can be furnished, or the drive may be coupled or belt connected to the driving means. **Graham Transmissions Inc.**, Menomonee Falls, Wis.

Circle 478 on Reply Card

Bin Level Indicator

Capable of being used in hazardous atmospheres such as vapors of ethyl ether, gasoline, petroleum, alcohol, acetone, lacquer solvent, natural gas and atmospheres charged with grain dust, carbon black, coal or coke dust, and atmospheres containing metal dust, including aluminum, magnesium and their commercial alloys, bin level indicator is the rotating paddle type.

A low torque motor, located in an explosion proof housing rotates the paddle at slow speed. Material building up to the unit stops the rotating paddle and stalls the motor. As the motor stalls, the torque of the motor actuates a limit switch to control signal lights, horns, motors of conveyors, or feeding machinery.

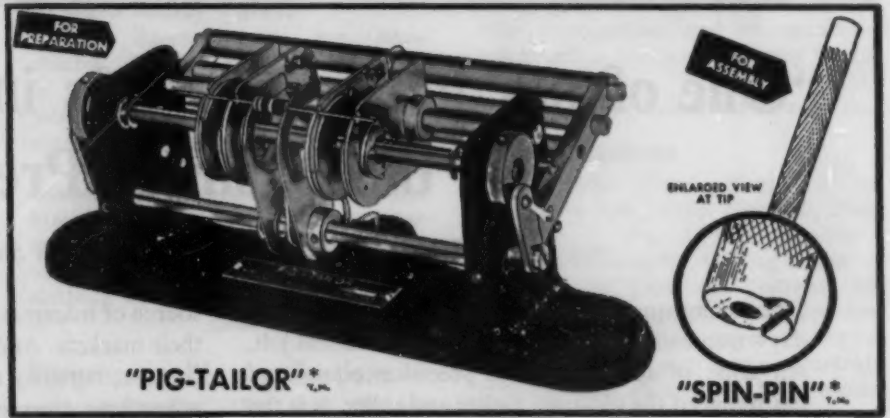


Unit is designed to indicate or control the level of any bulk material that will flow, from light aerated powders to heavy abrasive or lumpy materials. It is particularly suited for application on bins under pressure or vacuum. **Bin-Dicator Co.**, 13946-209 Kercheval, Detroit 15, Mich.

Circle 479 on Reply Card

"PIG-TAILORING"

. . . . a revolutionary new mechanical process for higher production at lower costs. Fastest PREPARATION and ASSEMBLY of Resistors, Capacitors, Diodes and all other axial lead components for TERMINAL BOARDS, PRINTED CIRCUITS and MINIATURIZED ASSEMBLIES.



The "PIG-TAILOR" plus "SPIN-PIN" — Accurately Measures, Cuts, Bends, Ejects and Assembles both leads simultaneously to individual lengths and shapes — 3 minute set-up — No accessories — Foot operated — 1 hour training time.

PIG-TAILORING provides:

1. Uniform component position.
2. Uniform marking exposure.
3. Miniaturization spacing control.
4. "S" leads for terminals.
5. "U" leads for printed circuits.
6. Individual cut and bend lengths.
7. Better time/rate analysis.
8. Closer cost control.
9. Invaluable labor saving.
10. Immediate cost recovery.

PIG-TAILORING eliminates:

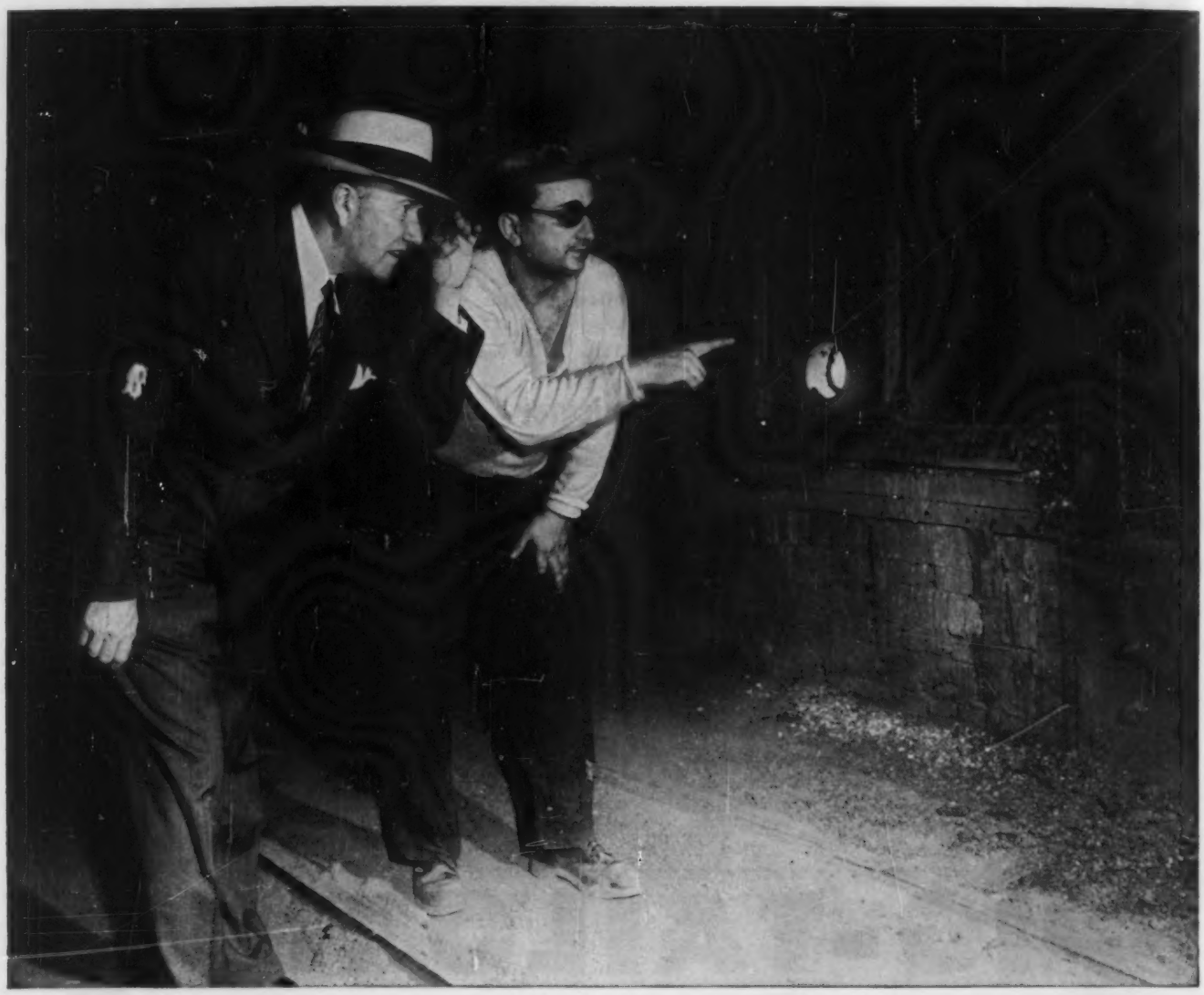
1. Diagonal cutters.
2. Long-nose pliers.
3. Operator judgment.
4. 90% operator training time.
5. Broken components
6. Broken leads.
7. Short circuits from clippings.
8. 65% chassis handling.
9. Excessive lead tautness.
10. Haphazard assembly methods.

*PATENT PENDING

Write for illustrated, descriptive text on "PIG-TAILORING" to Dept. A-12P

BRUNO-NEW YORK INDUSTRIES CORPORATION
DESIGNERS AND MANUFACTURERS OF ELECTRONIC EQUIPMENT
460 WEST 34th STREET • NEW YORK 1, N. Y.

Circle 601 on Inquiry Card



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catalogs and literature

Latest automation information. For copies use card page 17.

Lubricating Equipment

Oil-Rite Corp., 2318 Waldo Blvd., Manitowoc, Wis.—34-page catalog—Oil cups, oiling systems, dispensers, valves, level gages, filters, chain oilers are among the types of lubricating equipment described in Catalog No. 10. Photographs illustrate actual applications of automatic lubricators. Specifications and design features of models in the line are included.

Circle 480 on Reply Card

Air Valves

Mechanical Air Controls Inc., 10030 Capital, Oak Park, Detroit 37, Mich.—30-page catalog—Design and application of air valves is discussed in catalog entitled "The MAC Valve Story." Principle of valving as used in water faucets up through the evolution of simple straight-way and poppet type air actuated valves is covered in nontechnical language. Parts, structure and action of more complicated valves are also described and illustrated.

Circle 481 on Reply Card

Electronic Equipment

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.—356-page catalog—Equipment for industrial maintenance, research and production requirements is included in comprehensive catalog which lists over 27,000 items. Information on standard and special purpose electronic tubes, test instruments, voltage stabilizers, transformers, resistors, capacitors, printed circuit components, rheostats, relays, switches, rectifiers, photoelectric components, counters and a wide variety of other electronic equipment and components is included. Numerous illustrations are used, with specifications and ordering information given.

Circle 482 on Reply Card

Gear Motors

U. S. Electrical Motors Inc., P. O. Box 2058, Los Angeles 54, Calif.—16-page booklet—Used where heavy duty machines require nonfluctuating power at low speed or high torque, or both, line of Syncrogear motors is described in Bulletin No. 1880. Ratings from 1/3 to 30 hp with gear ratios as high as 10 to 1 are listed. Discussion of application of elliptoidal helical gears and a chart graphing degrees of tempering and hardening of gear teeth are also included.

Circle 483 on Reply Card

Printed Circuit Connectors

Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.—12-page bulletin—Designed to provide a positive connection between printed circuitry and conventional wiring, receptacles are the subject of illustrated bulletin. Series has types with 6, 10, 15, 18, 22 and 28 contacts in single or dual rows to accommodate up to 56 connections. Mounting and clearance dimensions, photographs and application data are included.

Circle 484 on Reply Card

By-pass Relief Valves

Fulflo Specialties Co. Inc., Blanchester, O.—12-page bulletin—Used in conjunction with oil hydraulic pumping units where a specific pressure must be maintained, by-pass piston type oil relief hydraulic valves are described and illustrated in bulletin. Maintenance and installation information are included, along with dimensioned diagrams and valve resistance charts.

Circle 485 on Reply Card

Progressive Die Applications

B. Jahn Mfg. Co., New Britain, Conn. — 20-page booklet — Photographs illustrate actual applications of dies used in combination with conveyor systems, presses and hopper feeding equipment to provide automated operations. Booklet contains illustrated case histories in which special dies were engineered to solve particular problems.

Circle 486 on Reply Card

Automatic Filtration

R. P. Adams Co. Inc., 404 Park Dr., Buffalo 17, N. Y. —10-page bulletin—Used in steel, paper and lumber mills, and other plants where fully automatic cleaning and continuous flow are essential, AWF filter machines are described in Bulletin 909. Available in three models, automatic machines have filter areas of 63, 95 and 116 square ft. Bulletin discusses three other types of filtering units which are used for high polish industrial water and for process liquids and gases. Installation photographs, specifications and features of the filters are included.

Circle 487 on Reply Card

Rotary Pump Selection

Wayne Pump Co., 220 Tecumseh St., Fort Wayne, Ind.—20-page booklet—Actual performance figures are used in comprehensive pump selection tables included in booklet. Line of internal gear rotary pumps is divided into five series, each of which is illustrated and described. Tables contain information enabling users to select proper pump models for specific applications, and recommended construction features for some 60 different liquids.

Circle 488 on Reply Card

Testing Systems

Burroughs Corp., Electronic Instruments Div., 1209 Vine St., Philadelphia 7, Pa.—16-page booklet—"Pulse Patterns for Testing Cores" is the title of Technical Bulletin 136 which discusses the use of pulse control systems to test cores by digital techniques. Diagrams illustrate method used in testing tape wound and ferrite cores. Control systems are also capable of testing other components by digital techniques.

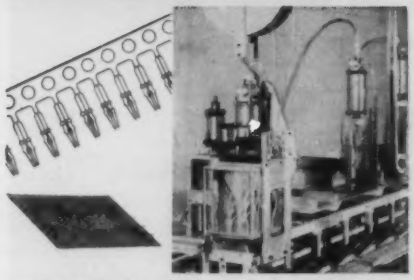
Circle 489 on Reply Card

Flow Controls

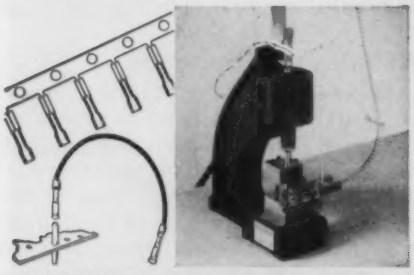
Fluid Controls Inc., 1284 N. Center St., Mentor, O.—8-page bulletin—Hydraulic restrictor and needle valves, and adjustable pressure compensated flow regulators are described in bulletin No. 553. Capacity ranges, pipe sizes and dimensions of each type are included, along with schematic drawings.

Circle 490 on Reply Card

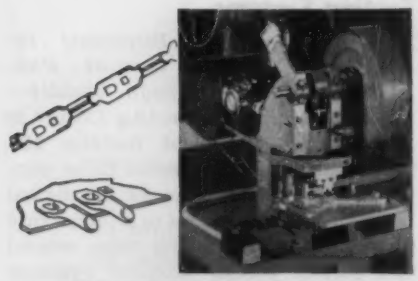
a complete line of
Printed Circuit Hardware
and
Terminal Inserting Equipment



Tubular Pin Terminals—Insert automatically into printed circuit board at huge production savings. Snap into position with positive locking action by means of self-retaining snap-in feature. Double ends permit wrapping or inserting leads at either end. Ask for Bulletins 550 and 551.



Solderless Wire Disconnect Female Terminals—Speedily applied to leads by means of cost-saving automatic equipment. Fits quickly and firmly to tubular pin terminals. Solderless wire crimp can be varied to fit various size insulated wires. Ask for Bulletin 553.



Line Cord Interlock Terminals—For single or multiple lead connections. Another Malco automation development to provide production short cuts and assembly economy. Terminals are staked quickly and firmly into printed circuit boards. Ask for Bulletin 554.

Malco printed circuit hardware can be engineered to your specific requirements. Give us the facts about your operation. We'll show you how your costs can be lowered and your production increased. Ask for Bulletin 551.

Malco TOOL and MANUFACTURING CO.
4017 W. Lake St., Chicago 24, Ill.

Circle 603 on Inquiry Card

Tubes in Cables

Crescent Insulated Wire & Cable Co., Trenton, N. J.—12-*page bulletin*—Used in the petroleum industry, chemical processing and paper industry, and other industrial instrument and control systems, armored Multitube system is the subject of Bulletin No. 356. System comprises spirally cabled tubing which is protected during and after installation against mechanical or corrosive injury. Features of various types of Multitube and methods of installation are discussed. Accessory equipment is also covered.

Circle 491 on Reply Card

Pneumatic Controllers

Bristol Co., Waterbury 20, *Conn.*—56-*page catalog*—Applicable for temperature, pressure, flow and vacuum control, Series 500W pneumatic controllers are the subject of Bulletin A130. Illustrated by more than 75 photographs and drawings, catalog includes information on control principles and available control modes.

Circle 492 on Reply Card

Specifying Corrugated Boxes

Hinde & Dauch, Sandusky, O.—28-*page handbook*—Information which enables manufacturers to do an efficient job of packaging is provided in handbook No. 7. Carrier regulations, how to determine the type and nature of a package, available types of corrugated board, etc. are discussed. Illustrations of regular slotted box, telescope design box, prescored folder and others are included.

Circle 493 on Reply Card

Liquid Level Sensing

Simmonds Aerocessories Inc., 105 *White Plains Rd., Tarrytown, N.Y.*—8-*page bulletin*—Designed to operate a lamp to indicate that gasoline, oil or other liquid is above or below a certain level, sensing system using a thermistor sensory element is the subject of Bulletin AD-404. System can also be used to provide control to start and stop pumps or operate valves to transfer liquid. Photographs, typical installations and information on thermistor properties are included.

Circle 494 on Reply Card

Continuous Slitting

Stanat Mfg. Co. Inc., 47-28 37*th St., Long Island City, N. Y.*—16-*page booklet*—Designed for mills, warehouses and strip users, line of rotary gang slitters is described in Publication No. 569. Sheet and coil slitting methods are summarized, with explanations of drive and pull-through slitting operations. Photographs show actual slitting operations; tables give cutting capacities and machine specifications. Several types of recoiling equipment and pay-off devices are also covered.

Circle 495 on Reply Card

Resistance Welders

Thomson Electric Welder Co., 161 *Pleasant St., Lynn, Mass.*—12-*page bulletin*—Line of custom engineered automatic resistance welders is the subject of illustrated bulletin. Machines for the welding of combustion chambers for jet engines, for producing vacuum cleaner bodies, and for welding truck and automobile bodies are pictured. Wire fabric, hack saw and brake shoe welders are also shown.

Circle 496 on Reply Card

Variable Transformers

Standard Electrical Products Co., 2240 *E. Third St., Dayton, O.*—22-*page booklet* — Line of Adjust-A-Volt variable transformers in auto, isolated and metered models for bench and panel mounting is described in booklet No. A56. Single and ganged units are illustrated, with dimension drawings, wiring and circuit diagrams included. Motor driven variable transformers for remote control operation are also pictured. A specification and application index completes the booklet.

Circle 497 on Reply Card

Vapor Degreasing

Circo Equipment Co., Degreaser Div., 51 *Terminal Ave., Clark (Rahway), N. J.*—24-*page catalog*—Used for cleaning metal parts prior to inspection or assembly, or in preparation for subsequent processing and finishing operations, line of vapor degreasers is described in catalog. Illustrated types include straight vapor, vapor and liquid, conveyorized units, etc. Information on installation, operating techniques, accessory equipment, solvents, metal washing equipment and ultrasonics is given.

Circle 498 on Reply Card

Heat Treating

Surface Combustion Corp., Toledo 1, *O.*—8-*page bulletin*—Use of a gas carburizing atmosphere furnace with dew point control to maintain the proper carbon potential is described in Vol. 7 No. 1 of Heat Treat Review in a story entitled "Improvement of Heat Treat Results with Modern Gas Chemistry." Information on the solution of a variety of heat treat problems and the use of a team of furnaces in an aluminum fabricating plant is also included.

Circle 499 on Reply Card

Variable Speed Unit

Reeves Pulley Co., Columbus, Ind.—*8-page bulletin*—Vari-Spin Drive is the name given to variable speed drive model 16-10E which is used for spinning frames and twisters. With Vari-Spin unit, speed adjustments can be made while the driven machine is running. Dimensions for installation are illustrated by large diagrams.

Circle 500 on Reply Card

Rotary Solenoids

Oak Mfg. Co., 1260 N. Clybourn Ave., Chicago 10, Ill.—*8-page bulletin*—Engineered as simple solenoid units, rotary selectors with switch sections or complete remote control unit subchassis, line of rotary solenoids is covered in illustrated bulletin. Dimensional chart is included, along with information on mechanical supplements and eight engineering data charts.

Circle 501 on Reply Card

Regulating Feeders

Hardinge Co. Inc., 240 Arch St., York, Pa.—*12-page bulletin*—Used to control the rate of withdrawing materials from bins or hoppers and discharging them to conveyors or subsequent processing equipment, regulating feeders are the subject of Bulletin 33-E. Design details, capacities, dimensions and applications of constant weight, weight-measuring, volumetric belt, disk, and volumetric nonflooding drum feeders are included.

Circle 502 on Reply Card

Automation of Business Systems

Moore Business Forms Inc., Niagara Falls, N. Y.—*12-page bulletin*—The continuous and integrated operation of data processing using automatic machines is described in bulletin. Five steps to automatic data processing—system analysis, equipment study, forms design, forms construction and integration—are discussed. An ADP flow chart and typical problems and their solutions are also included.

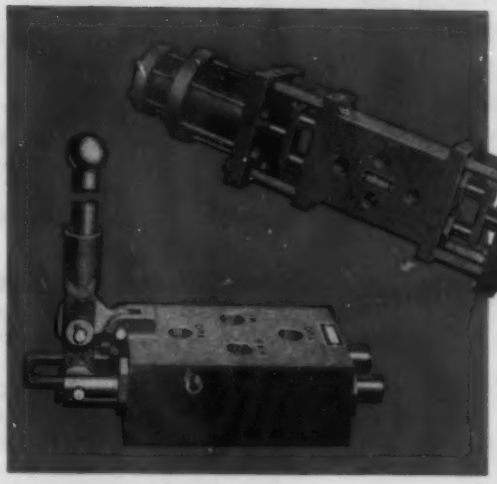
Circle 503 on Reply Card

Spray Painting

Ransburg Electro-Coating Corp., Indianapolis 7, Ind.—*16-page booklet*—Application examples of the No. 2 process of electrostatic spray painting are illustrated in booklet. Diagrams are used to show the basic process. Complete automatic coating unit which consists of electrostatic voltage source, electrical controls, insulators, atomizers and coating material supply system is provided by the manufacturer. Users furnish the conveyor, workholders and solvent ventilation.

Circle 504 on Reply Card

Quick-As-Wink® HYDRAULIC VALVES



Double Pilot Cylinder Operated 3-position 4-way Hydraulic Valve

(At left) Lever Operated 3-position 4-way Hydraulic Valve

Hand and Pilot-operated Types for water or hydraulic oils to 5000 psi.

• These valves give users maximum efficiency, economy and dependability. Housings are milled from steel blocks or bronze forgings. The hollow, radially ported, stainless steel plungers are hard chrome plated and polished. Renewable metal valving rings assure long life of the packers which are expanded by internal pressure . . . the higher the pressure the tighter the seal. No metal to metal seating. The valves are fully balanced in any position. Inspection — and servicing if necessary — can be done easily *in the field*, avoiding the delays of returning valves to the factory for servicing, or the need to carry large inventories of standby valves — or even parts. Complete dimensions, capacities and other data sent promptly. Write for Bulletin No. 531,— Today!

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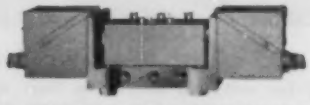

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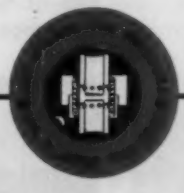

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Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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Circle 604 on Inquiry Card

Hydraulic Equipment

Century Hydraulics Inc., 7703 Lyndon Ave., Detroit 38, Mich.—*17-page booklet*—Oil level sight gages, breather caps, filler-breather assemblies, clarifiers, and reservoirs are discussed in booklet. Dimensions, mounting information and prices are included.

Circle 505 on Reply Card

Vibration Monitoring

Beta Corp., Box 8625, Richmond 26, Va.—*8-page bulletin*—Used to protect all types of rotating equipment against damage in the event of failing bearings or other mechanical malfunctions, Model 5 Vibraswitch is described in Bulletin No. 500-5. Malfunction detector features electrical reset for automatic hold-in during starting or normal transient disturbances. Ordering information, specifications and diagrams showing dimensions and terminal connections are included.

Circle 506 on Reply Card

Automatic Pneumatic Gages

Moore Products Co., Philadelphia 24, Pa.—*8-page bulletin*—Used for control both during and after grinding, line of air gages for automatic operation is described in Bulletin 8006. Photographs and drawings illustrate typical examples of the gages in use. Manually operated gages for measuring ID, OD, thickness, squareness, etc. are also illustrated and described.

Circle 507 on Reply Card

Furnace and Oven Controls

Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Aves., Philadelphia 44, Pa.—*46-page catalog*—Line of strip chart, circular chart and circular scale instruments is described in Catalog B43-1. Information on instrumentation for metal processing applications includes specifications of vane-type millivoltmeter controllers, thermocouples, radiation detectors, remote bulb thermometer controllers, limit controls, electric and pneumatic valves.

Circle 508 on Reply Card

Remote Control Components

Norden-Ketay Corp., 99 Park Ave., New York, N. Y.—*10-page bulletin*—Precision resolvers for phase shifting, data transmission and industrial process controls; gear head servomotors which feature low backlash; and magnetic servoamplifiers for use with a wide range of servomotors are described. Photographs, specifications and diagrams are included.

Circle 509 on Reply Card

Air Cylinders

S-P Mfg. Corp., 30201 Aurora Rd., Solon, O.—*12-page bulletin*—Twenty-one models of air cylinders, ranging from 1½ through 14-inch bore sizes are illustrated in catalog. Engineering data on line of valves and accessories are also included.

Circle 510 on Reply Card

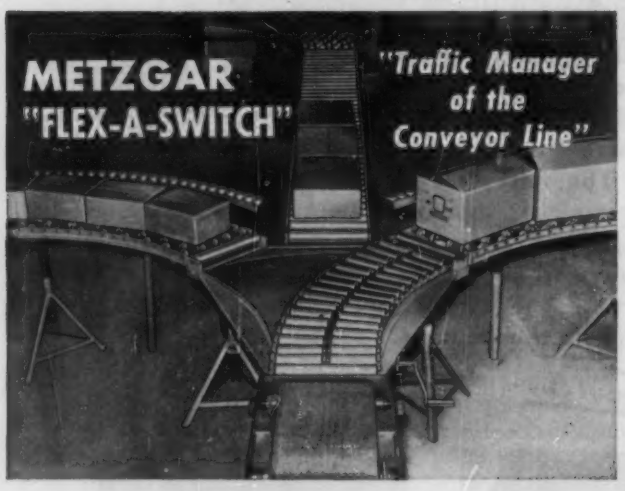
Stepping Switches

Stromberg-Carlson Co., Div., General Dynamics Corp., 100 Carlson Rd., Rochester 3, N. Y.—*12-page bulletin*—Used for selecting particular circuits from a group, finding an idle circuit, or performing consecutive operations in separate circuits, line of stepping switches is the subject of illustrated bulletin. Models of XY universal and Deca switches are shown in close-up photographs and their specifications and features are described.

Circle 511 on Reply Card

Photoelectric Controls

Photoswitch Div., Electronics Corp. of America, One Memorial Dr., Cambridge 42, Mass.—*24-page catalog*—Packaged photoelectric systems for industrial control applications including conveyor control, counting, inspecting and sorting, etc. are described in Bulletin PA 561. Line of



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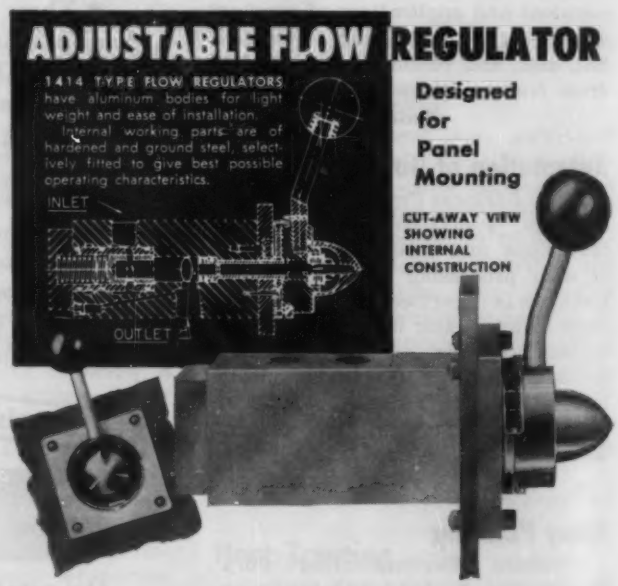

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miniature and subminiature photoelectric receivers and light sources is introduced. Specifications and operational charts are included.

Circle 512 on Reply Card

Gearing and Slide Lubrication

Farval Corp., 3249 *E.* 80th *St., Cleveland* 4, *O.*—8-*page bulletin*—Automatic spray lubrication system for heavy duty service is one of the centralized lubrication systems covered in Bulletin No. 60-A. Information on systems for open gearing and sliding surfaces, schematic layouts and actual application photographs are included.

Circle 513 on Reply Card

Packaging Devices

Signode Steel Strapping Co., 2600 *N. Western Ave., Chicago* 47, *Ill.*—48-*page catalog* — Automatic wire tying machines are among devices illustrated and described in Catalog No. 17, "Packaging and Carloading Guide." Photographs, descriptions and application instructions for strapping, seals, strapping tools, grain doors, retaining strips, etc. are also included.

Circle 514 on Reply Card

Mechanical Press Valves

Danly Machine Specialties Inc., 2100 *S. Laramie Ave., Chicago* 50, *Ill.* —8-*page bulletin*—Designed to actuate the clutch and brake of mechanical power presses, Model 2545C dual air valve is described in Bulletin 1902B. Design of valve prevents accidental stroking due to valve failure. Photographs, specifications and mounting diagrams of the device are included.

Circle 515 on Reply Card

Process Control Development

Feedback Controls Inc., Dept. A, Waltham, Mass.—12-*page bulletin*—New bulletin entitled, "A New Concept in Process Control," indicates company facilities for handling phases of control system development. Accomplishments of the company in industrial control systems, computer and guidance systems, instrumentation and automatic data processing are summarized.

Circle 516 on Reply Card

Dust and Fume Control

American Wheelabrator & Equipment Corp., Mishawaka, Ind. — 38-*page catalog*—Used for continuous or intermittent ventilating of grinding operations, mixers, weighing scales, bag handling systems, etc., line of Dustube collectors is the subject of Catalog 72-B. Continuous automatic models are used where the process to be ventilated is continuous and the volume and concentration of dust handled is great. Basic equipment is available in four different types. Installation photographs, specifications, and discussion of auxiliary equipment are included.

Circle 517 on Reply Card

Positioning Table

Arter Grinding Machine Co., Worcester, Mass. — 4-*page pamphlet* — Used with 4-ft or larger radial drills, or under any suitable drill spindle, fully automatic positioning table is called the Jigmatic. Pamphlet includes specifications, photographs and discussion of the tape-controlled device.

Circle 518 on Reply Card

Synchronous Induction Motors

Allis-Chalmers Mfg. Co., 1205 *S.* 70*th St., Milwaukee, Wis.*—4-*page pamphlet* — Useful where constant speed is required, several motors must operate at fixed speed ratios, or speed must be adjustable with no variation at a given setting, Synduction motors are described in Bulletin 51B8440A. Motor has such applications as motor-alternator sets, frequency converters, printing presses, and wherever there are definite sequences in a continuous operation. Photograph, application notes and typical speed-torque curve are included.

Circle 519 on Reply Card

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P&B engineers had this problem concerning the newest jet bomber: reduce a highly complex relay application approximately nine times—in a hurry! The miniaturization must maintain extra fine sensitivity and unquestioned reliability.

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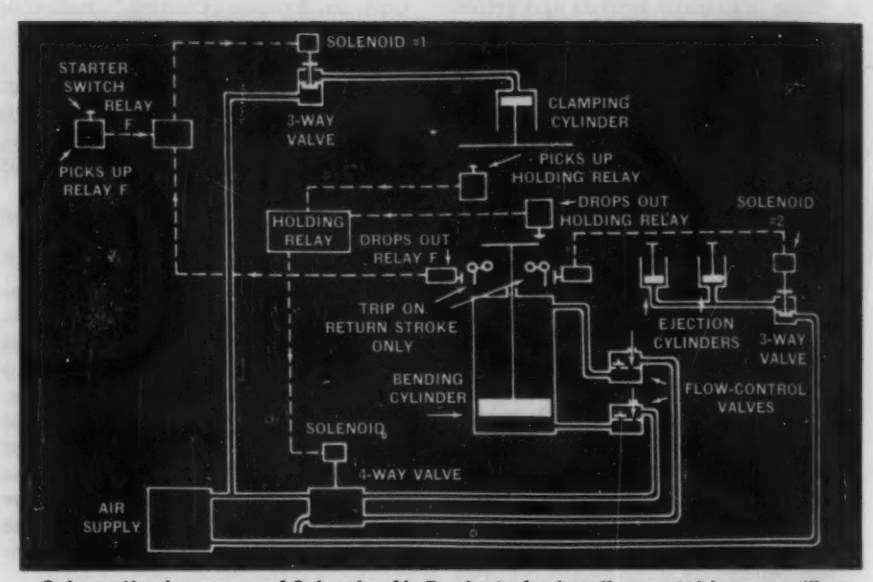

Schematic shows use of Schrader Air Products for bending metal burner grills.

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The accompanying schematic shows the simple arrangement of Schrader Air Products which the company developed with the help of Schrader engineers. The rapidity achieved in production, amazingly enough, is coupled with much greater safety and economy, two other features inherent in the use of air.

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AUTOMATION abstracts

POSITIONING WITH NUMERICAL CONTROL

By EDWARD E. KIRKHAM
Project Engineer
Pratt and Whitney Co.

THE OPERATION of machine tools from recorded information is of great current interest. There are two major classes of numerically controlled machine tools: contouring (or continuous path) milling machines and positioning machines. In the latter the path followed to arrive at the drilling or boring location need not be described by the numerical data fed to the machine; instead this program may be established by built-in control features selected to give the desired precision and speed of operation. Each slide may be set independently of the others. We shall discuss positioning control applied to a vertical spindle jig boring machine having a horizontal table capable of moving the work piece under the spindle.

The first requirement of a numerical control system is a suitable method of handling and storing the digital data. A casual observation of systems already in office use indicated that punched records were preferable to magnetic or optical storage mediums because of the simpler equipment required to sense a punched hole as compared to that required to detect a magnetic spot or a variation in optical density. It immediately became apparent that the choice of a medium would be dictated by equipment available for handling that medium. However, office equipment did not appear to be suitable for shop use. It was thought best to design a unit which specifically meets the requirements of our customers: mechanical ruggedness and electrical reliability under shop conditions. The mechanism for handling punched tape without damage to it can be much simpler than that necessary for handling cards; also, the tape may be automatically rewound. In order to make use of paper as well as plastic tapes, it is desirable that the density of information on the tape be low so that variations in tape size or position will not result in reading errors. For that reason a tape wider than that usually used in office equipment was chosen.

Static Tape Reader

There are two distinct means of reading the information from a punched record. One of these is the dynamic method in which a small group of holes is sensed at one instant and the information so read is stored. The tape is run until this buffer storage unit accumulates a sufficient number of digits for the machine tool to accomplish one operation.

The static reading method eliminates the need for the buffer storage. The punched record is already a storage medium and the greatest reliability will be obtained when the storage capability of the tape is used. The tape is moved into position and stopped; then all the

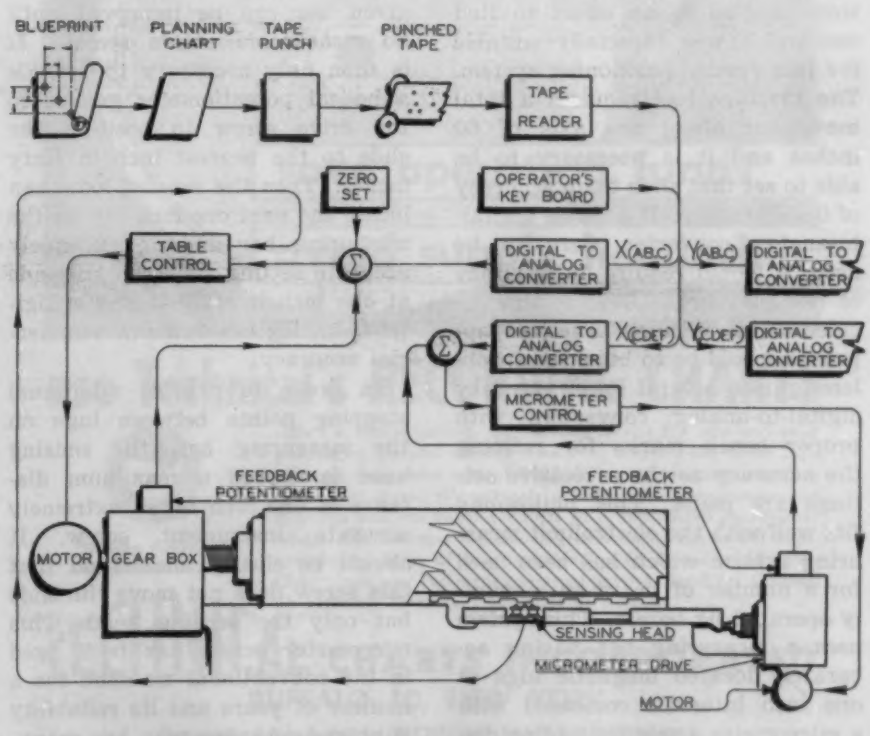

Fig. 1—Positioning system uses several digital-to-analog converters and an electrolimit measuring system to obtain requisite accuracy in setting slide to nearest 0.0001-inch in 60 inches of travel.

data necessary for a single machine operation are read at one time and that data presented to the machine tool continuously. When the machine operation has been completed and checked, the tape can then be advanced one field or block so that new information may then be presented. The tape used has twelve rows across it. Ten of these are for the digits zero through nine, and two additional rows are used for tape control. One of these latter two rows is used for identifying each block of information and the other row is used to provide automatic rewind and stop-rewind. The hole indicating the beginning of a new block of information is sensed by the reader for the purpose of stopping the tape at an appropriate point so that the entire block of information will be in register over the proper columns of the tape reader.

The tape reader design that was selected uses a pneumatic sensing system. Air is forced through holes in the tape to an enlarged chamber with a neoprene diaphragm providing sufficient force to operate a reliable industrial control limit switch.

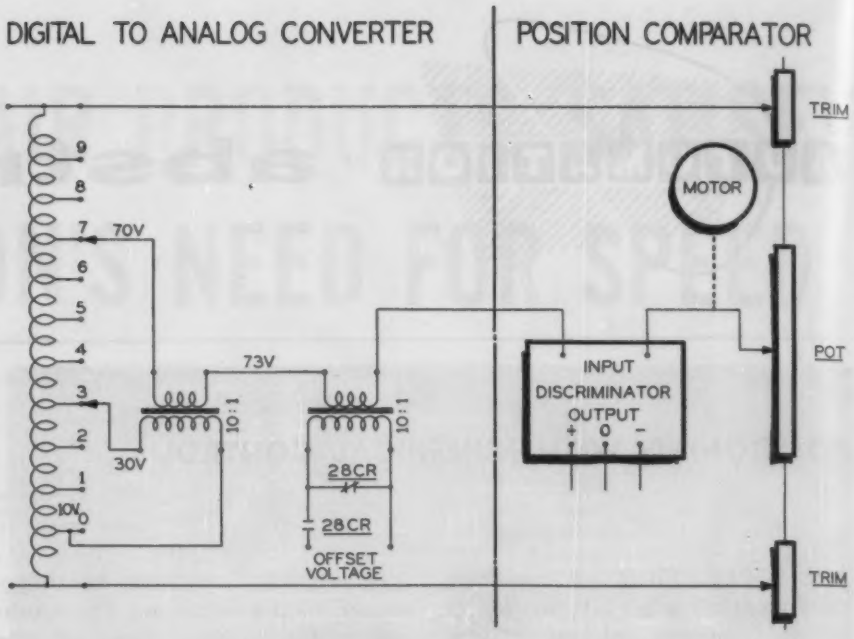

Fig. 2—Readings are converted to voltage signals as air is forced through holes in the tape to move a diaphragm with sufficient force to activate limit switches connected to appropriate taps on an auto-transformer.

Measuring System

Many systems of measurement were studied in an effort to find one which was especially suitable for this precise positioning system. The machine tool requires a total movement along one axis of 60 inches and it is necessary to be able to set that slide to an accuracy of 0.0001 inches. If a single digital-to-analog converter were to be used, it would require an accuracy of one part in 600,000. It was decided that a more practical approach would be to break the problem up into several lower accuracy digital-to-analog converters with proper bench marks for refining the accuracy as the successive settings are made. This philosophy fits well with the electrolimit measuring system which has been used for a number of years on manually operated jig borers. This system uses a measuring bar having accurately located magnetic lugs at one inch intervals combined with a micrometer screw for adding distances less than one inch. The magnetic center lines of these lugs can be sensed by an inductance bridge circuit with the sensing head so positioned that the lugs move by it without any mechanical contact. It is possible to calibrate this measuring bar by stoning the sides of each lug independently. The accuracy is not limited by the manufacturing technique; rather the accuracy of a given bar can be improved until no measurable errors remain. It is then only necessary to provide a helical potentiometer geared to the drive screw to position the slide to the nearest inch in sixty inches. Then the sensing head can locate the next one-inch lug on the measuring bar and an extremely accurate setting can then be made at one inch intervals using a digital-to-analog converter of commercial accuracy.

In order to provide additional stopping points between lugs on the measuring bar, the sensing head is moved a maximum distance of one inch by an extremely accurate instrument screw. It should be clearly understood that this screw does not move the slide but only the sensing head. This micrometer screw has been used in the conventional machine for a number of years and its reliability is proved. Anyone who has manufactured such instrument screws is familiar with the difficulty of providing a screw of accurate lead and satisfactory linearity at the same time. Lapping the nut to the screw can provide linearity but will usually produce some error in lead. We have provided means, however, for compensating for lead errors in the electric control system and, therefore, we make the screw uniform in lead to an accuracy of one part in 50,000.

Electrical Operation

As soon as the automatic or manual switch calls for a new position, the tape is advanced to the next block signal hole. The tape stops and the pneumatic switches are operated corresponding to the punched holes. The switches for the first two digits before the decimal point connect to appropriate taps on an auto-transformer to produce an analog voltage of magnitude proportional to these digits. The auto-transformer has a distinct advantage over the usual two-winding type in that undesired phase shifts, caused by leakage reactance in one portion of the winding, are offset by identical effects in the other portion. If phase shift is permitted, an imperfect null will result at the balance point.

Notice that the tape is checked for double punch and blank column

for each digit read. Closure of more than one contact for a given digit will result in a short circuit on the digit transformer which will trip a magnetic overload relay. Failure to operate at least one switch will also cause a short circuit. These short circuit currents are limited by a series resistor.

This analog voltage is fed to a discriminator which compares it to the voltage fed back from a helical potentiometer geared to the table drive screw. The output of this discriminator is used to operate the multispeed gear box to position the table approximately.

The two digits immediately following the decimal points are fed into the micrometer screw drive to obtain its approximate position. This approximate position is made exact by means of an additional bench mark system. These bench marks are at 0.0100 inch intervals.

Similarly, the third and fourth digits following the decimal point are fed into still another digital-to-analog converter which provides a signal that is compared with a feedback potentiometer for setting the screw at positions between bench marks.

Mechanical Considerations

After the table has come to its approximate position and the sensing head has been moved to its exact position by the micrometer drive, the table is advanced at a very low speed until the sensing head indicates correspondence between the measuring bar lug and sensing head. The table is then stopped and the screw reversed to release tension.

Thus, the slide has been positioned to the required accuracy of one part in 600,000 using three individual digital-to-analog converters, each requiring an accuracy of only one part in 100. The manner of approach has been permanently programmed into the control system so that the machine always makes its final setting in the same direction and at a series of velocities which have been previously established.

The velocity of final approach must be such that when the set point is finally reached the variation in coasting distance of the

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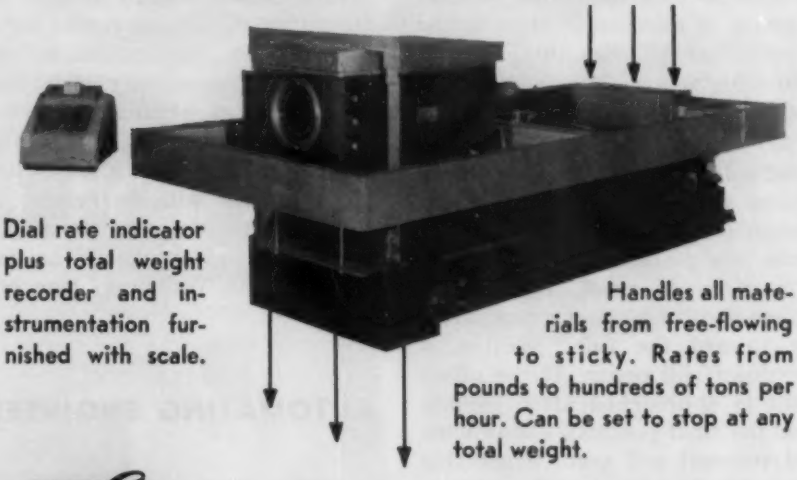

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slide, due to variation in coefficient of friction, must be within the tolerance desired for the final setting. Calculations, confirmed by experiments, have established that this speed of final approach must be extremely low. In order to make settings in a reasonable length of time, it is then necessary to have a series of slowdowns prior to the final approach. In this application a four-speed drive is used having an overall ratio of 2500:1.

Actually the input data are altered a small amount by the control system so that the slide will not approach the final set point but will come to a place which is displaced in a given direction. If the slide approaches this offset point, moving toward the final position, a slowdown will occur. If the offset point is approached after passing over the final position, a slowdown and reversal will occur. Once this offset has ben reached further reference to the feedback potentiometer will not be required because the slide will have then been located to the nearest inch. The table will subsequently be moved to the proper lug under the control of the sensing head.

While the table makes its approximate setting, the micrometer has been moving into the required position in accordance with the four digits following the decimal point. Here again the settings are offset so that the final setting can always be made in the same direction thus insuring that backlash and any possible deformations will always be in the same direction. Upon completion of the micrometer setting the table is allowed to continue until the sensing head balances, indicating that the table has reached its final position. The slide is then automatically clamped by a non-influencing, air-operated clamp and the drive screw is then reversed sufficiently to remove any strain on the driving nut.

Of course, as many additional slides as desired can be set simultaneously. We are constructing machines having as many as five numerically controlled slides which can be in operation simultaneously.

Control Applications

Jig borers are customarily used for the production of accurate tools, dies, templates, jigs, and for other precise production. Numerical positioning of the slides of such a machine will certainly be helpful even in the manufacture of a single part. Good jig boring technique requires that all holes to be bored first, be spotted one at a time, all rough drilled, rough bored, and finish bored. This prevents distortion due to relieving of stresses during the machining operations. The series of settings, therefore, may have to be made four to six times just to produce a single part. Tape control will be helpful for these one-time parts. It will be even more advantageous on production jobs, including gear case covers and jet engine casings. Also, the same machine is frequently used for the inspection of parts because of its ability to measure. Some machines are built with a special column designed for measuring deviations from nominal position rather than for machining processes.

Rotary tables can be controlled precisely using an analogous positioning system applied to a circular slide.

From a paper entitled, "Precise Positioning With Numerical Control" presented at the American Institute of Electrical Engineers Conference on Machine Tools in Cincinnati, Oct., 1956.

AUTOMATING ENGINEERING TASKS

By JOSEF KATES
President
K.C.S. Data Control Ltd.

WHEN DISCUSSING the automation of engineering tasks it is useful to reflect for a minute on the nature of engineering itself, how engineering has brought about automation and then how automation techniques may affect engineering techniques.

Engineers might well appropriate to their art the invention of the wheel, the early metallurgy of copper and brass, the fashioning of various tools etc. We could discuss the construction of the pyramids, the design of Phoenician ships, the war contraptions of Leonardo da Vinci, the experiments of Galileo and Newton. But in those early days engineering was not a separate profession and the men who noticeably advanced the art of applied science, were usually a combination of artists, writers, scientists, medical practitioners, alchemists and architects.

Engineering as a separate profession, which requires the entire devotion and skills of an individual and which is marked by a body of disciplines, an educational curriculum, professional organizations and accepted public status, grew out of the increasing technical tempo of the Industrial Revolution of the 19th century.

Just as the Industrial Revolution was marked by the substitution of mechanized power for human or animal power, so the mass product of today is made possible by the introduction of interchangeable parts and the assembly line. It is the assembly line which enables society to exploit to the fullest the increase in efficiency which accompanies division of labor.

The increasing replacement of man by the machine in production and distribution, coupled with the increasing complexity of goods and machines, is placing a growing emphasis on the part that engineering takes in our economy. The total number of engineers is rising, the ratio of engineers to other workers is quickly increasing. engineering is taking a bigger and bigger bite of the consumer's dollar. For example in 1945 Ontario had 4291 engineers, in 1955 there were 14000 engineers, and the Association of Professional Engineers of Ontario forecasts 26,000 engineers for 1965. This means that the working force per engineer has fallen from 368 in 1945 to 145 in 1955 and is expected to fall to 100 in 1965. In the United States about 1 engineer is required for every 75 production workers, whereas 1 engineer used to suffice for every 200 production workers. Shortages of engineers are devel-

oping in many areas. Our economy seems to be headed into a bottleneck, an engineering bottleneck.

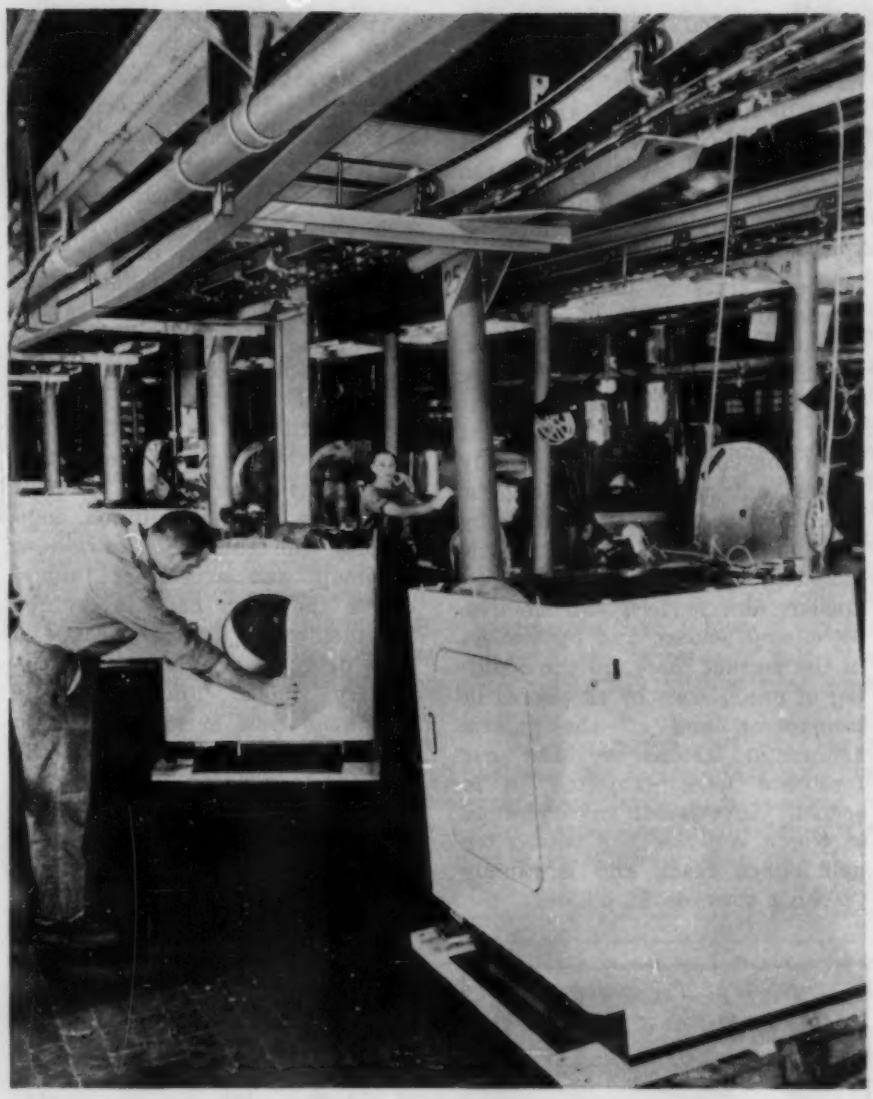
Engineers have no vested interest in inefficiency. They alone can provide the answer to this rapidly growing problem, an answer which lies partly in the application of the engineer's methods to his own art. No longer can we look at the rest of humanity blessed with methods and efficiencies generously dispensed by engineers, while engineers themselves carry on from specification to end product as in the days of old, from slide-rule to drafting board, from approximation to pilot model. In short, if, for better or worse, we are to continue our present rate of material progress, engineers will have to automate some of their own tasks.

Automation Applied to Engineering

There appears to be agreement on two chief characteristics of automation. These are: That automation involves processing of information as well as processing of materials; and that automation involves the performance of lengthy and complex sequences of operations without human intervention.

If we look closely at engineering techniques we find that in essence they involve lengthy and complex sequences. The process of meeting a specification by means of a design is essentially an information-processing problem which involves bringing together the data of the specification with data about materials, performance data of machines and experimental facts. The processing of these data with the know-how and experience of the designer eventually results in a design, a blueprint, a production or a distribution method. The automation of such processes will require information processing machines. Engineers have provided us with these in the form of computers.

In some engineering fields such as nuclear and aircraft engineering, where engineering has always been the major bottleneck, computers have already been accepted



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as an essential part of the engineer's tool kit. While computers have also been applied successfully to almost every other engineering endeavor, we believe that the surface has only been scratched and that fuller utilization of computers in engineering is bound to follow when there is intensive training and deeper understanding not only of computer essentials but of the scientific and mathematical basis underlying each engineering discipline.

A safe estimate indicates that electronic computers have already carried out more basic arithmetic operations than have been done by all humanity since Adam and Eve, including all the calculations by ancient and modern astronomers, by money lenders and by traders in the market place, all the counting of sheep done by shepherds or insomniacs, and all the painful arithmetic lessons we and our forebears were subjected to in school. Investment in computers in North America has passed the half billion mark and is rapidly reaching towards $1 billion.

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Analysis and Synthesis

Many engineering tasks have the following pattern. A specification is laid down. Experienced designers make a synthesis; that is, they propose a design which will probably come close to satisfying the specifications. This proposed design is then analyzed and if the analysis shows discrepancies between the forecast performance and the specifications, the design is altered slightly and analyzed again until the specifications are met. In this sequence the synthesis carries most of the glamour and leans most heavily on engineering imagination, know-how, judgment and experience; analysis on the other hand is typified by much of the drudgery, cost and time delay in arriving at a satisfactory design. For instance, a bridge analysis must be preceded by a design proposal. Here the structural engineer uses his experience to propose the number of longitudinal and transverse members to be used, their shapes and the positions of supports. This initial design proposal can then be subjected to analysis and evaluation. At present so many factors seem to enter the formulation of the initial design, that it would probably be entirely uneconomical if not impossible to entrust this part of the engineers' work to the computer.

For this reason most computer applications have concentrated on analysis while synthesis in the majority of projects will for a long time remain the prerogative of the engineer. It has proved quite difficult and usually quite uneconomical to feed varied and wide experience and engineering know-how into a computer. Compared to the human memory the the memory of even the largest machine is quite minute. In other words we can reach a point of no return even with computers.

On the other hand analysis usually requires the carrying out of some specific calculations for which the computer is very much faster, more reliable and more flexible than the human operator. It follows that the best use of computers will result where the experienced engineer teams up with the computer and the computer is entrusted with the carrying out of the lengthy routine sequences. Since most engineering techniques do not fall by themselves into such a happy combination of sequences which involve experience, imagination and know-how, followed by lengthy routine analytical procedures, efficient application of computers to engineering problems will require considerable analysis and regrouping of techniques if the fullest benefits are to be obtained. Experience to date shows quite conclusively that this rearrangement of engineering techniques can have very effective results in speeding up and lowering the overall cost of projects. In addition such analysis often results in a deeper understanding of the engineering application studied.

The division between analysis and synthesis is, of course, not rigid and immovable. On the contrary, if automatic methods are to be fully exploited continuous effort will be needed to develop analytical procedures, in replacement of synthetic procedures, to standardize, and to routinize, and to refine existing routines even further.

It is typical that most engineering applications of computers to date have not been merely replacement of identical techniques carried out manually before the introduction of computers. For instance the type of stress analyses described above have been quite impractical to do manually and the testing of structures had to be done previously by building and loading scale models. So we do not find many instances which an engineering function has been replaced exactly by the computer. Rather computers are used to a large extent for the carrying out of analyses and refinements which would have been impractical previously.

Overall Computer Uses

The computer is not an engineering tool alone. In the computer room the engineer will meet the manager, the accountant, the methods and procedures man, the scientist and the statistician. In analyzing situations for computer applications the engineer will often

find it wise to get together with these other members of the industrial team. Production efficiency is tackled at present under two labels; in the factory—industrial engineering, in the office—systems and procedures. Both disciplines finally lead into more general problems, the systematic solution of which has been labeled operations research. Operations research has as its chief object the most effective utilization of men, machines and raw materials; it draws from engineering and accounting techniques and leans heavily on mathematical methods which often require computers.

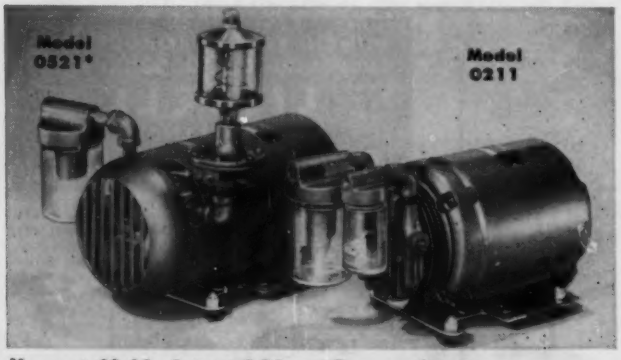
It is interesting to note that computers have been received by engineers with enthusiasm rather than with the suspicion and barriers which are often thrown up against new techniques and machines. In most instances engineers have been quick to realize that computer techniques open new opportunities rather than displace engineers. Engineering groups provided with such potent tools display unmatched zeal and intensity. Programming itself is one of the first tasks to be automated by engineer-programmers; this means that programs are developed by means of which the computer carries out automatically much of the burdensome coding and checking required for further programs. One might consider this as the automating of automation.

It should now be clear that electronic computing techniques can be used to automate those functions of the engineer which can be routinized; and in automating these functions engineers can be freed for other functions in the performance of which the human being far surpasses the machine. Naturally the increased engineering productivity which will accompany automation ought to increase the engineer's standard of living just as rising productivity has increased living standards of the population in general.

Above all, technical competition between industries, and competition from abroad whether economic or political, whether friendly or hostile, requires that each industry and this country as a whole see to it that technical personnel be used as efficiently and effectively as possible. In times of boom or times of war, programmed computers will be an invisible reserve which will go a long way towards alleviating critical personnel shortages.

In reviewing ten years developments in this field, and recalling some of the dire predictions which have been made, one thing becomes clear: Man may fashion ever more powerful tools for the harnessing of nature's forces. Yet it is plain that these tools will never simulate so closely man's infinite variety and versatility that they will become more than a tool. They can never take the place of man himself. We will always need engineers!

From a paper entitled, "Automating the Engineer's Task" presented at the annual meeting of the Engineering Institute of Canada in Montreal, May 1956.



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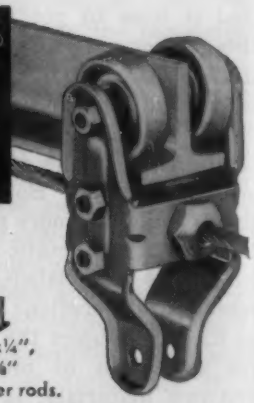

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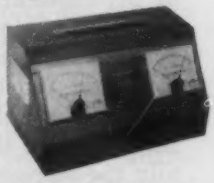

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AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents. Washington 25, D. C.

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LIGHT SENSITIVE AUTOMATICALLY CONTROLLED STEERING SYSTEM

Photoelectric control system guides a harvester along the boundary of an uncut crop by using two source-detector cell pairs, one for reference and one in which the uncut crop obstructs the optical path. Patent 2,751,030 by Fay E. Null.

APPARATUS FOR METERING OF MOLTEN METAL BY WEIGHT

Equipment automatically controls the flow of metal from a ladle in accordance with a predetermined pattern of flow rates by positioning the ladle stopper in relation to sensed weight of the ladle. Patent 2,753,605 by Richard J. Carleton Jr., assigned to Republic Steel Corp.

ELECTRONIC POSITION AND MOTION CONTROL SYSTEMS

Moving and positioning mechanisms are controlled by means responsive to voltages generated by deflection of an index element. Patent 2,753,-468 by Amos J. Carr Jr., assigned to Raytheon Mfg. Co.

• • •

Measuring

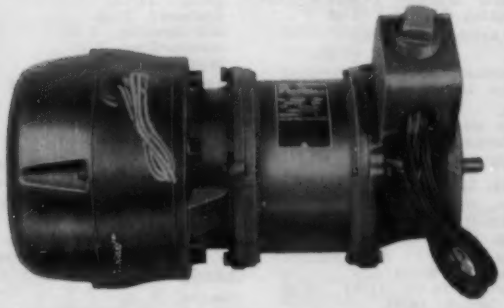
APPARATUS FOR CONTINUOUSLY DETERMINING MASS PER UNIT LENGTH

Mass per unit length of a material such as yarn is continuously determined by measuring the natural frequency of vibration of the strand as it passes through the apparatus. Patent 2,744,408 by John S. Seney, assigned to E. I. du Pont de Nemours & Co.

MEASURING APPARATUS

Magnitude of a variable is transmitted by sound waves generated by the vibration of a string whose tension is changed in proportion to the magnitude of the variable. Patent 2,751,577 by Robert C. Du Bois, assigned to Minneapolis-Honeywell Regulator Co.

Where Special Requirements Dictate Motor Construction



This peculiarly shaped motor opens and closes pipe line valves without fail in all types of weather. It is a special weather-proof torque motor designed by **Peerless Electric** in cooperation with a valve manufacturer and is equipped with an electrically operated brake. The motor shown here measures approximately 10" in diameter and 31" in length but **Peerless** can produce it in many other sizes.

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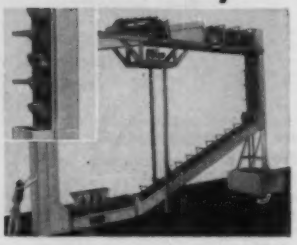

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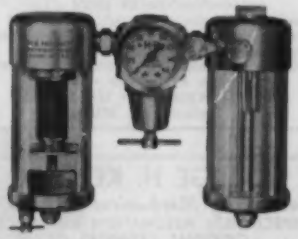

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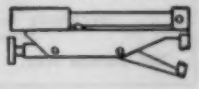

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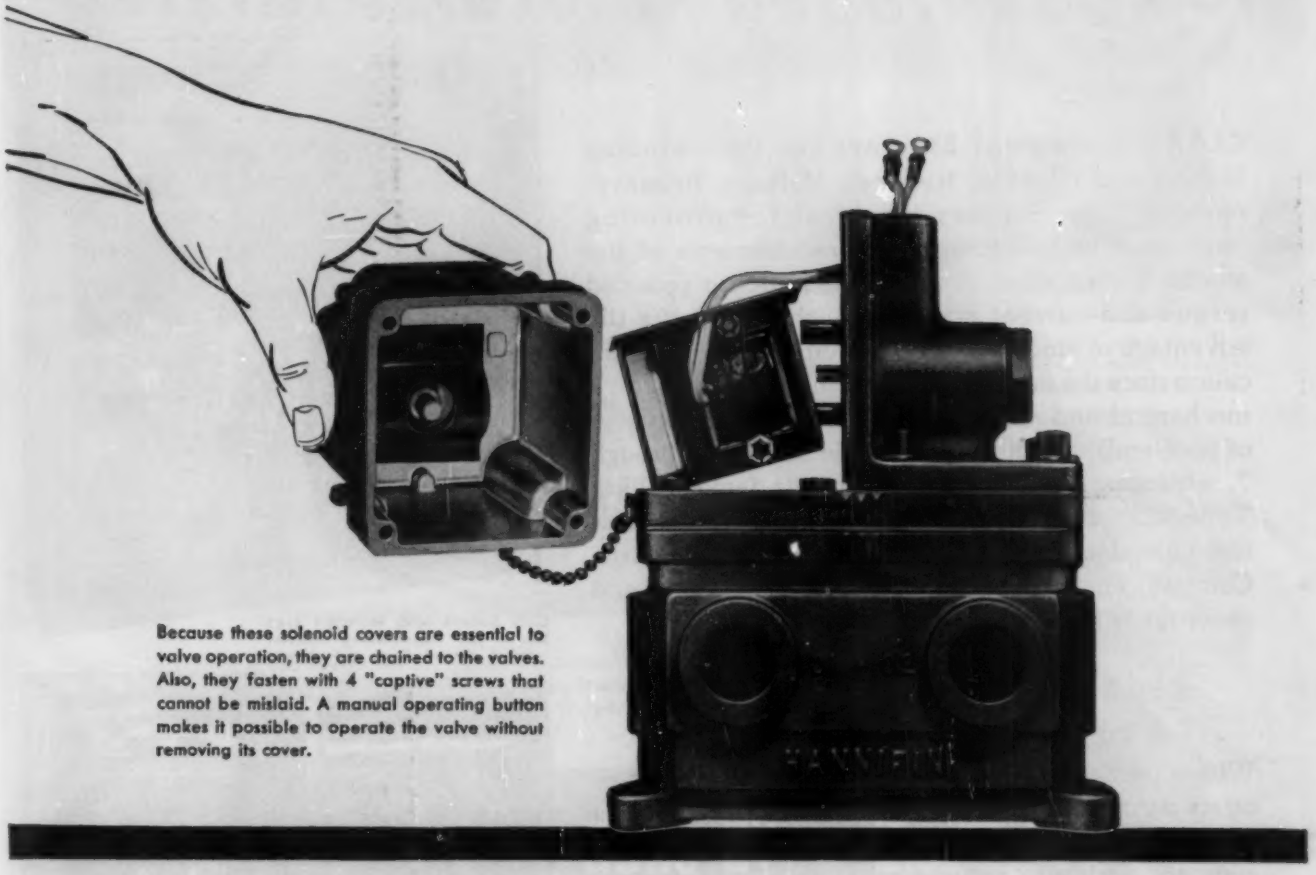

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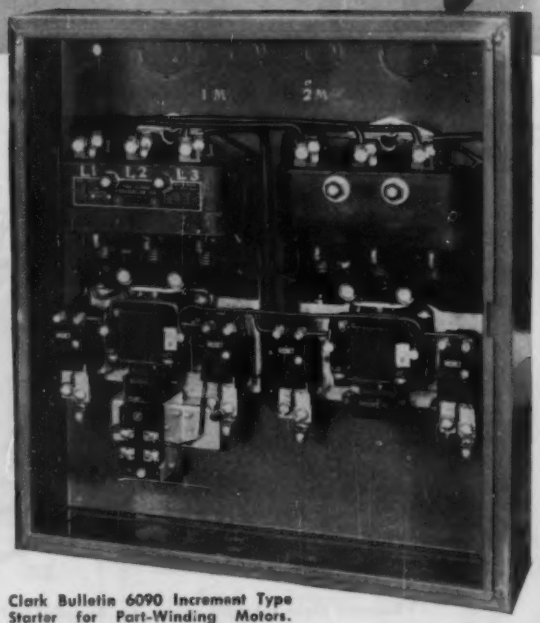

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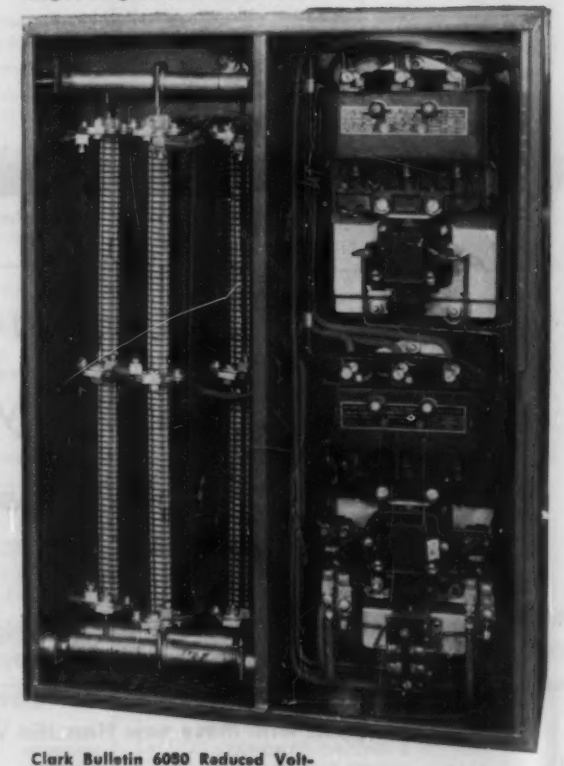

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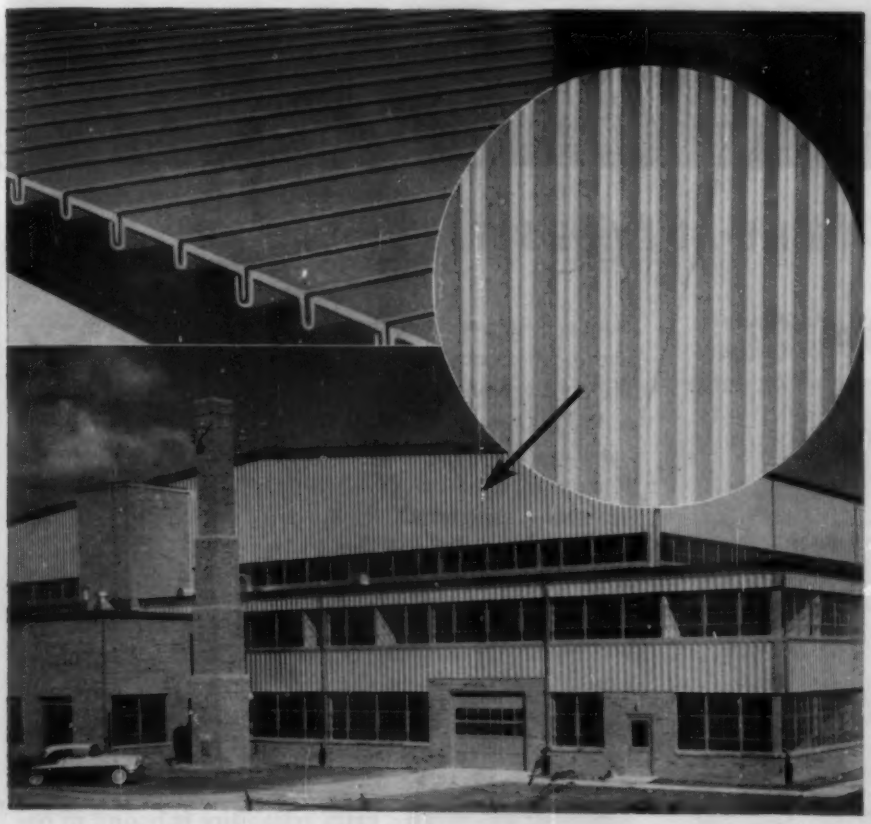


(TOP) *Cross-section of cold-roll-formed Roof Deck by Walker Supply & Mfg. Co., Ecorse, Michigan.*

(INSET CIRCLE) *Aluminum siding panels, (made by Walker Supply & Mfg. Co.) give fine architectural effect.*

Elevator Door, Casing and Trim, by Dahlstrom Metallic Door Co., Jamestown, N. Y.

1001 things being done by COLD ROLL FORMING

The Cold-Roll Forming Machine is a powerful weapon in the hands of mass-production metal-working industries striving to fight inflationary forces with technological advances.

This applies even to the building industry, long considered immune to mass-production methods. The field abounds in opportunities for cost reduction through cold-roll forming of components for quick and easy assembly and erection on the job. The list includes, for example, specially designed wall, partition, floor and roof systems, nailable studs and joists, cabinets, closets, windows, doors and trim. It even includes exterior coverings, for architectural beauty as well as insulation and weather protection (see photo above).

The Yoder Book on Cold-Roll Forming contains numerous illustrations with information on the economic and mechanical possibilities of cold-roll forming, the machines and the tooling. Yoder has long been looked up to as the leader in designing and building all such equipment. A copy of the book is yours for the asking.

THE YODER COMPANY • 5526 Walworth Avenue, Cleveland 2, Ohio

ENGINEERING YODER MANUFACTURING

COLD ROLL FORMING MACHINES

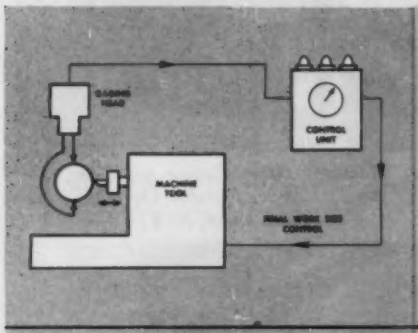
ROTARY SLITTING LINES

PIPE AND TUBE MILLS—Electric Weld

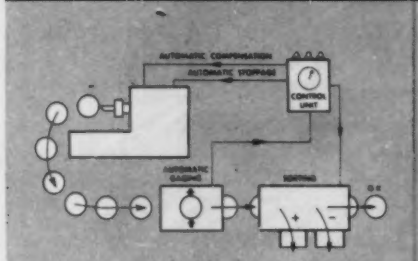
Why FEDERAL offers more

RELIABILITY THRU DIVERSIFIED EXPERIENCE

Diversity in Automatic Control



IN-PROCESS
control utilizes gage to make tool retract when part has been machined exactly to correct size.

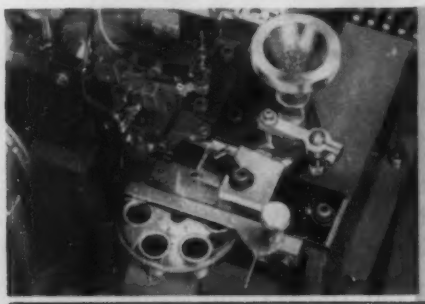


POST-PROCESS
control provides feedback of corrective signals from automatic gage to machine to maintain part uniformity. Federal pioneered both this and "In-Process" type of control.

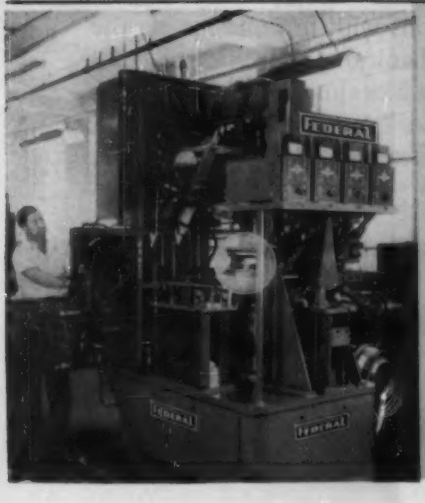
Any type of precision gage should be reliable, but when the gage becomes part of the automated process, reliability becomes of premium importance. There's a lot at stake. Over the years Federal has developed numerous ways to greatly increase Automation Gaging reliability. For instance . . . using extremely low voltage at sensitive switching contacts. This eliminates pitting, and tremendously prolongs contact life, maintains precision. And, Federal Automatic Gages employ electronic switching . . . vastly more accurate, faster, and more maintenance-free than the use of mechanical means to actuate work-handling relays.

You don't come by these features overnight. They are the result of hard-headed experience acquired in the designing and building of many diversified types of automatic gages. This extra reliability is bound to pay off. It's reliability which you not only can afford, but which *you cannot afford to do without.* And, only Federal provides it!

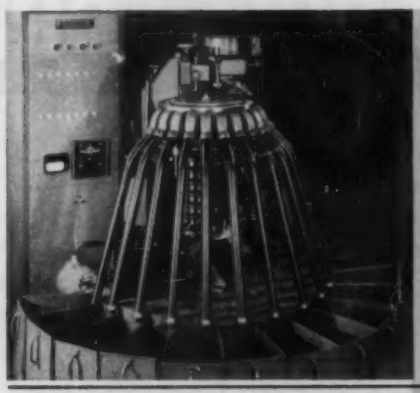
Diversity in Automatic Inspection



WATCH JEWELS
Each jewel is the size of a pin-head, yet this gage automatically handles, checks and sorts 1800 per hour! Gage measures hole in jewel only .008" in diameter.



TRUCK WHEELS
This Federal Gage automatically checks 500 massive truck wheels an hour for radial and lateral runout, sorts into good and bad.

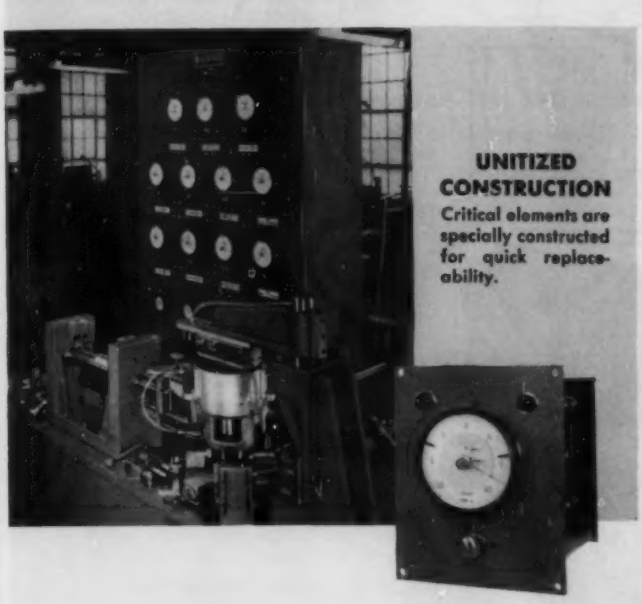


24,000 PIECES PER HOUR
This high speed automatic gage checks diameter of various size ball bearings, sorts into 12 categories of .000010" each!

21 DIMENSIONS
2400 per hour. This gage is adjustable to automatically handle 13 sizes of turbine blades, measuring almost two dozen dimensions in only 4 stations.

in Automation Gaging!

SIMPLICITY THRU STANDARDIZATION



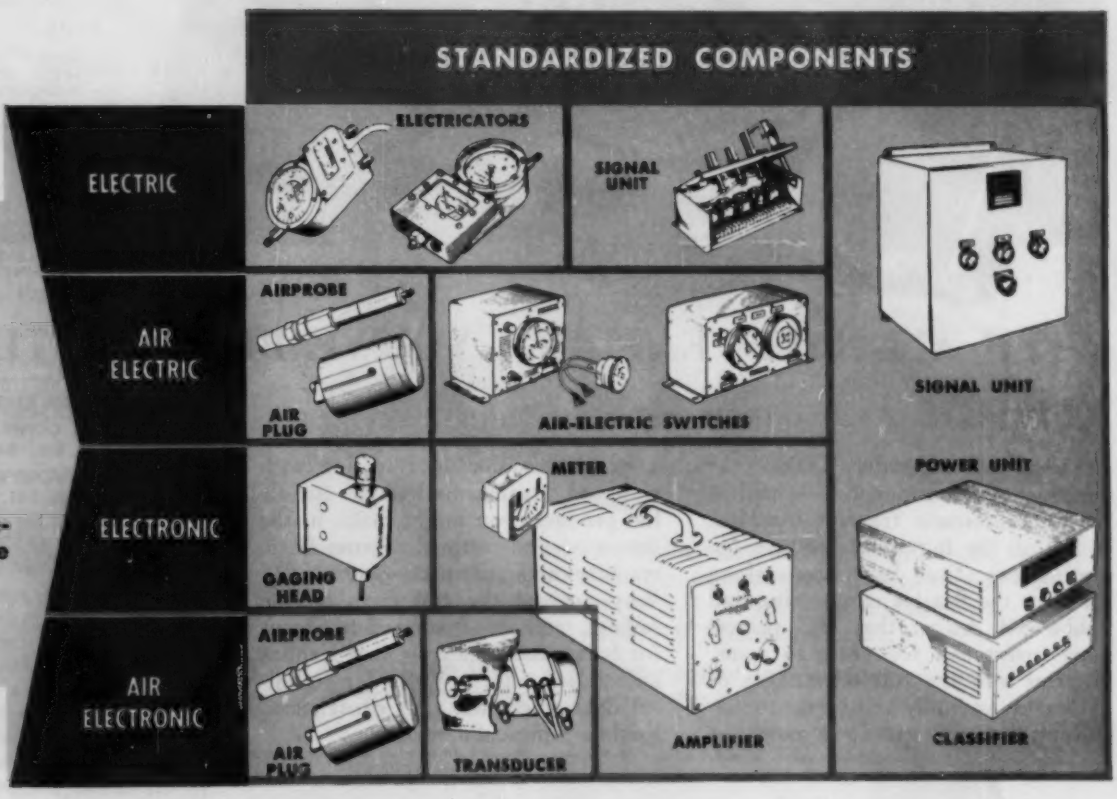
UNITIZED CONSTRUCTION
Critical elements are specially constructed for quick replaceability.

Automation will never become wholly standardized, but Federal — because it has had such long-time experience in this field — is able to meet most control and inspection demands using basic, standardized components. This means lower costs for you, for one thing . . . but much more importantly . . . it means greater reliability of performance. It means this too — much less dependence on technical talent and immediate service. Standardized units can be replaced with spares quickly and easily, should the need arise. What sizable savings in downtime costs!

This is the kind of common sense design you should have in return for your Automation Gaging investment . . . and Federal can give it to you. Ask your nearest Federal representative to come in and discuss this in terms of your own needs.

FEDERAL PRODUCTS CORPORATION
63912 EDDY STREET • PROVIDENCE 1, R. I.

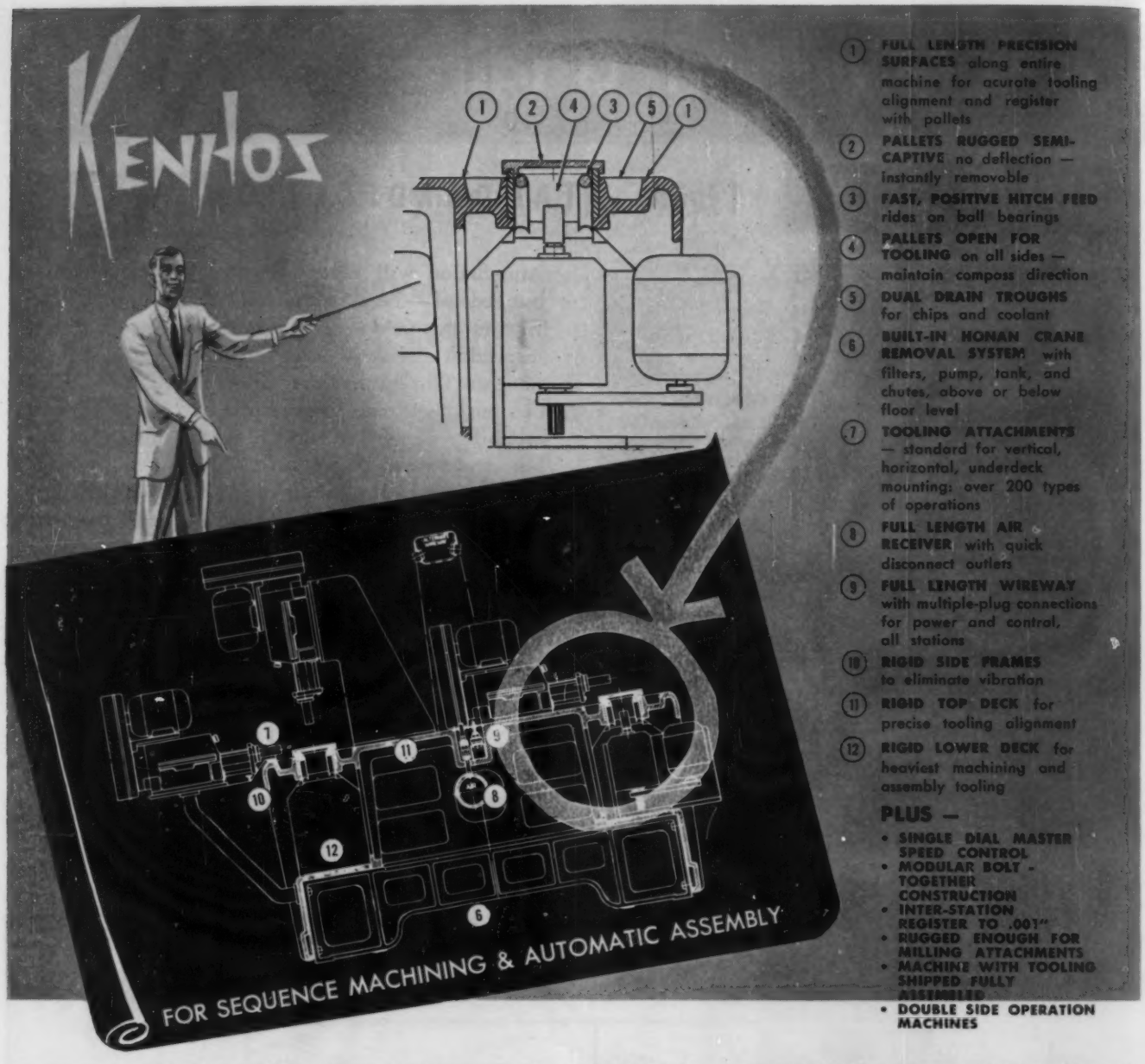
4 SYSTEMS OF GAGING
Only Federal provides this flexibility to meet gaging requirements more economically.



Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging



1. **FULL LENGTH PRECISION SURFACES** along entire machine for acurate tooling alignment and register with pallets
2. **PALLETS RUGGED SEMI-CAPTIVE** no deflection — instantly removable
3. **FAST, POSITIVE HITCH FEED** rides on ball bearings
4. **PALLETS OPEN FOR TOOLING** on all sides — maintain compass direction
5. **DUAL DRAIN TROUGHS** for chips and coolant
6. **BUILT-IN HONAN CRANE REMOVAL SYSTEM** with filters, pump, tank, and chutes, above or below floor level
7. **TOOLING ATTACHMENTS** — standard for vertical, horizontal, underdeck mounting; over 200 types of operations
8. **FULL LENGTH AIR RECEIVER** with quick disconnect outlets
9. **FULL LENGTH WIREWAY** with multiple-plug connections for power and control, all stations
10. **RIGID SIDE FRAMES** to eliminate vibration
11. **RIGID TOP DECK** for precise tooling alignment
12. **RIGID LOWER DECK** for heaviest machining and assembly tooling

PLUS —

- **SINGLE DIAL MASTER SPEED CONTROL**
- **MODULAR BOLT - TOGETHER CONSTRUCTION**
- **INTER-STATION REGISTER TO .001"**
- **RUGGED ENOUGH FOR MILLING ATTACHMENTS**
- **MACHINE WITH TOOLING SHIPPED FULLY ASSEMBLED**
- **DOUBLE SIDE OPERATION MACHINES**

WITH ALL THE FEATURES YOU'VE BEEN WAITING FOR!

KENHOS Automatic transfer machine

At last, you can safely make your decision to go automatic — with a Kenhos automatic transfer machine. It has all the important features operating executives have been asking for, plus the flexible engineering and field-tested design that will protect your investment for years to come. It gives you the full advantages of automatic assembly and sequence machining for your products now, yet a simple, economical retooling with standard attachments lets you handle the products you might make in the future — all with the same basic machine and automatic controls.

Why not get the full facts on the savings and production advantages for today and tomorrow that Kenhos automation offers. Write for technical data or contact your experienced Kenhos representative now.

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HARTFORD, CONN., Machine Tool Sales, Inc., Box 426

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. . . . . or write direct

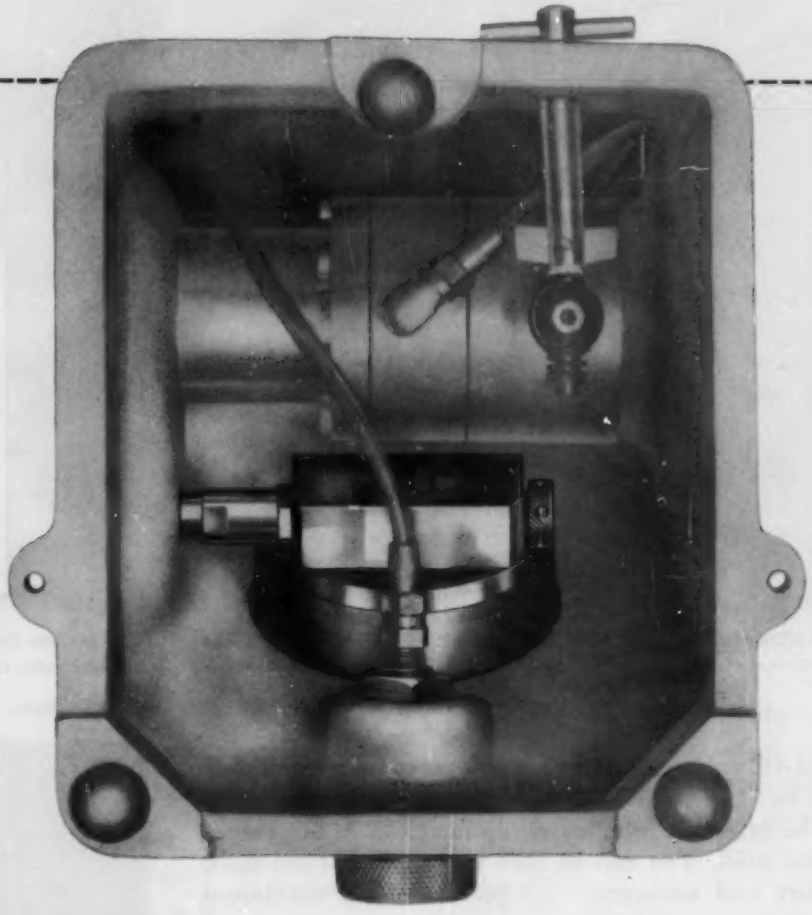
KENHOS CORPORATION 275 Connecticut Ave., Norwalk, Conn.
Associated with George H. Kendall, Consulting Mechanical Engineers and Specialists in Automation Processes.

Get this Inside Story

for Lower-Cost Air Gaging

This simple venturi tube, and its corresponding dial, is the real key to more accurate, more trouble-free air gaging performance. The Taft-Peirce CompAIRator uses this tube in a unique *Venturi Circuit* which provides advantages not found in any other type of air gage. Check these exclusive extras . . .

- Easy and inexpensive magnification changes — switch this venturi and dial in just five minutes
- Only 10 pounds operating pressure, cuts air cost in half
- Fast reaction permits remoting base unit from fixture without using "booster" — no time lag or lowered sensitivity
- Velocity-type venturi circuit permits checking smallest diameters with standard gaging members — ID's down to .055″
- Wide tolerance range: can gage tolerances as narrow as .0001″, or can be designed to check as wide a range as .125″
- Full linearity through 180° of dial scale
- Built-in fast response, easily tied in with automatic machining and inspection operations
- Can be mounted at any angle without disturbing readings



Taft-Peirce Single Dial CompAIRator, complete with plug and masters. CompAIRators are also available in double or multi-dial units, can be used with standard air plugs, air rings, and air snap gages — directly attached to cabinet or to air hose. Special fixtures designed and built to order.

The simple Venturi circuit, extreme flexibility, and trouble-free operation make Taft-Peirce Air Gaging your lowest-cost quality control tool — whatever the production rate. It has been proved in hundreds of installations, performing all kinds of gaging operations.

Get ALL the facts . . . from your nearest Taft-Peirce representative, or write direct for Air Gage Catalog No. 613.

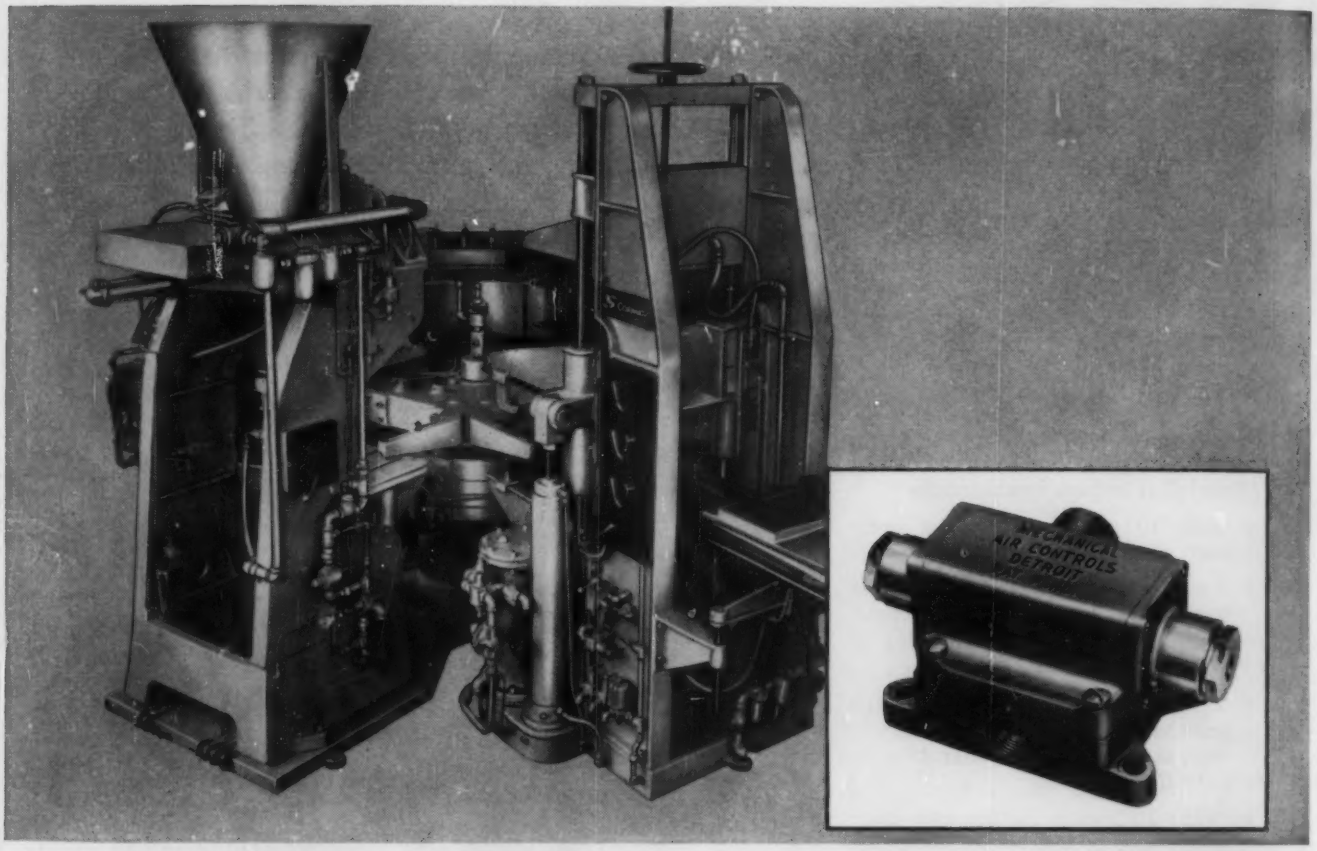
TAKE IT TO TAFT-PEIRCE

TAFT-PEIRCE MANUFACTURING CO.
WOONSOCKET, RHODE ISLAND

T-P Means TOP Precision

Circle 566 on Inquiry Card

1200 SHELL CORES AN HOUR... and AIR DOES THE WORK



AUTOMATION COMES TO FOUNDRIES with Beardsley & Piper's new "Cormatic". Its intricate *all-air* control circuit features 33 MAC valves . . . provides the split-second operation needed to produce up to 1200 close-tolerance shell cores an hour using multiple core boxes.

MAC valves are showing up everywhere—*and well.* The "Cormatic" above proves the point. Here, on the latest in foundry equipment, 33 MAC valves are used. You can be sure they'll withstand dust, dirt and moisture . . . perform with maximum efficiency, minimum maintenance.

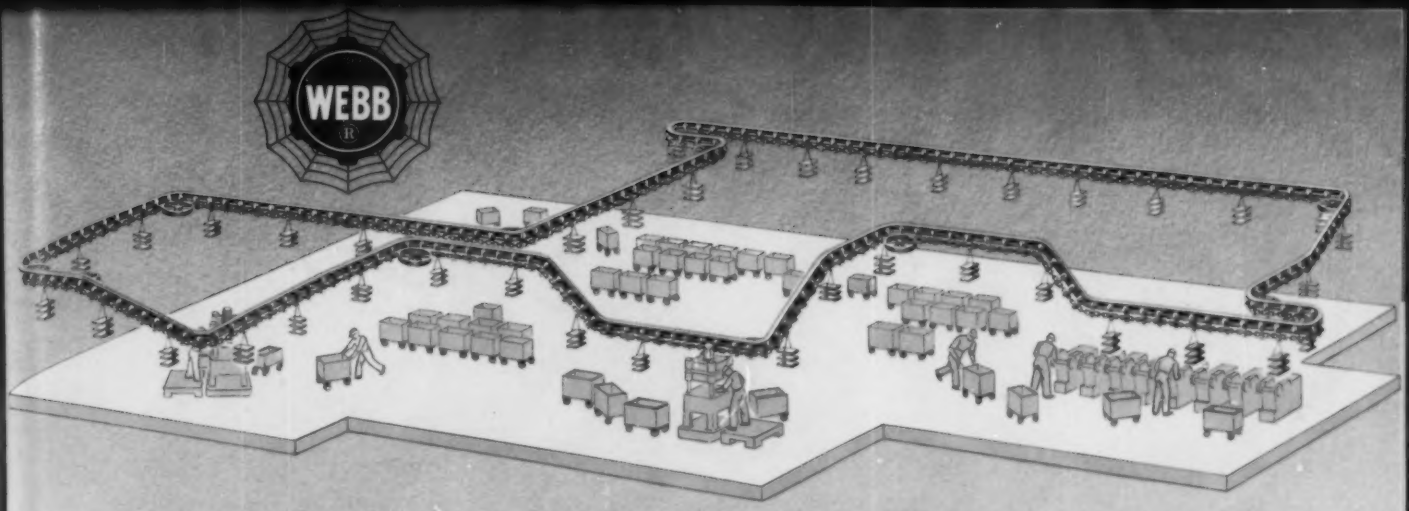
Why not check MAC for all *your* original equipment or replacement needs? You'll find MAC valves lighter, more compact, with fewer parts to wear. The line is complete, too—a wide range of sizes in pilot, pilot-operated and solenoid models.

***Write for free booklet,* THE MAC VALVE STORY. In layman's language, it tells you what you should know about the design and application of air valves—MAC valves in particular. Or contact a representative listed at right for your free copy. No obligation, of course.**

MECHANICAL AIR CONTROLS, INC.

Office and Factory—10030 Capital, Oak Park, Detroit 37, Michigan

MAC



This Webb Lightweight Conveyor processes chrome parts from trim presses through buffing operations. Overhead system provides a constant re-circulating inventory. Eight other X-228 Conveyor's are used in conjunction with one above to provide a complete overhead handling system.

WEBB X-228 CONVEYORS

Lower Your Costs *for* Handling Light Loads

THE NEW X-228 I-BEAM

The new I-beam developed by Webb for X-228 conveyors is accurately rolled and of high carbon steel. It provides a strong smooth roadway for the 2-inch trolleys and its unusual rigidity requires fewer support members. X-228 I-beams are comparable in their high quality to 3, 4 and 6-inch beams used for heavier-duty Webb conveyors.

A large parts manufacturer is benefiting by handling chrome trim parts on nine Webb 2″ trolley conveyors. Combined length of installation totals more than 4000 feet. Uneven production rate formerly created a bulky storage and inventory problem. Now, overhead conveyors provide recirculating inventory flow . . . eliminate floor congestion . . . open up additional space for other manufacturing operations . . . greatly reduce manual handling. Parts flow is automatically controlled, constant and efficient.

This lightweight 2″ trolley conveyor is designed specifically for the efficient and economical conveying of small or light parts (trolley capacity up to 75 pounds). Users achieve manufacturing efficiency without paying the cost of a heavy duty conveyor. How about your manufacturing operations? Do you have a handling problem involving light parts? If so, Webb X-228 is the right conveyor for you.

Webb also makes trolley conveyors in larger capacities to handle heavier loads. Many other types of Webb conveyors are available for efficient handling of any product or material regardless of bulk, weight or size. For more information on the lightweight X-228 conveyor, or any other Webb conveyor, contact the Webb District Office near you, or write direct.

JERVIS B. WEBB CO.

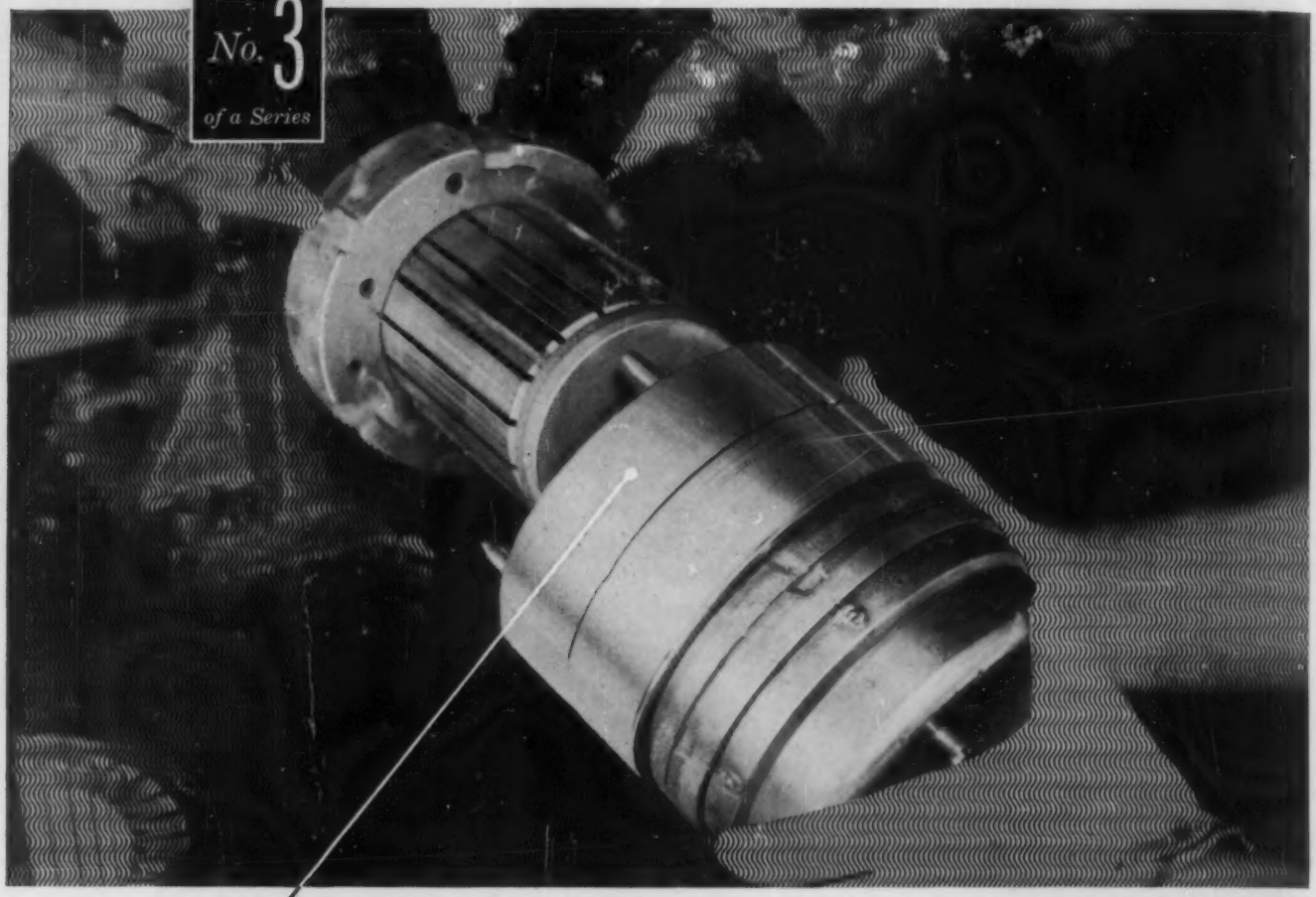
Specialists in Custom Conveyor Systems

3945 ALPINE AVENUE • DETROIT 4, MICHIGAN

FACTORIES: DETROIT • ATLANTA • LOS ANGELES • HAMILTON, ONTARIO, CANADA • ENGLAND • FRANCE • AUSTRALIA

Erickson Precision Expanding Mandrels Solve Assembly Problems

No. 3 of a Series



Photos: Courtesy The Emerson Electric Mfg. Co., St. Louis

e.g. electric motor stators

Emerson Electric, big-name electrical manufacturer, assembles stator laminations the modern way—with Erickson Mandrels. Gone are the old-fashioned arbor assembly methods that require a large tolerance between laminations and arbor . . . that lead to eccentricity of stator bore and to additional finishing operations on the OD.

Emerson Electric works "from the inside out" with Erickson Precision Expanding Mandrels. Laminations are placed on a fixture and the fixture slipped over the expanding mandrel. Laminations are then welded together with two passes through a three-torch head.

Result? Stators are concentric within Erickson's guaranteed accuracy of five "tenths." And Emerson Electric gets a better motor with uniform air gap . . . that produces uniform torque and rated horsepower . . . that creates minimum electrical interference . . . and that lasts longer.

If this cost-cutting case history triggers your imagination, contact the nearest Erickson representative. He'll be pleased to demonstrate how Erickson Precision Expanding Mandrels can cut your assembly costs.

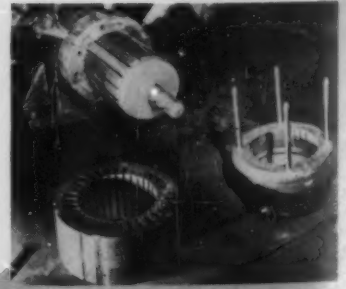
AA-4133

Collet Chucks
Floating Holders
Tap Chucks
Indexers

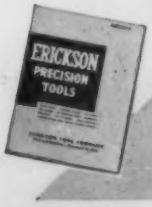
ERICKSON TOOL COMPANY

2300 Hamilton Avenue • Cleveland 14, Ohio

Tap Holders
Air-Operated Chucks
Expanding Collets
Special Holding Fixtures



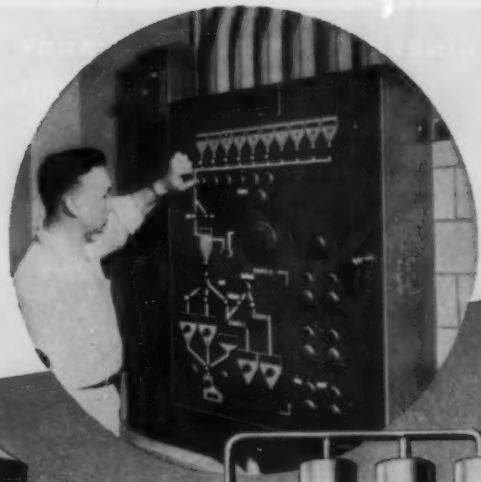
ID of stator assembly (lower left) requires no finishing operation after welding.

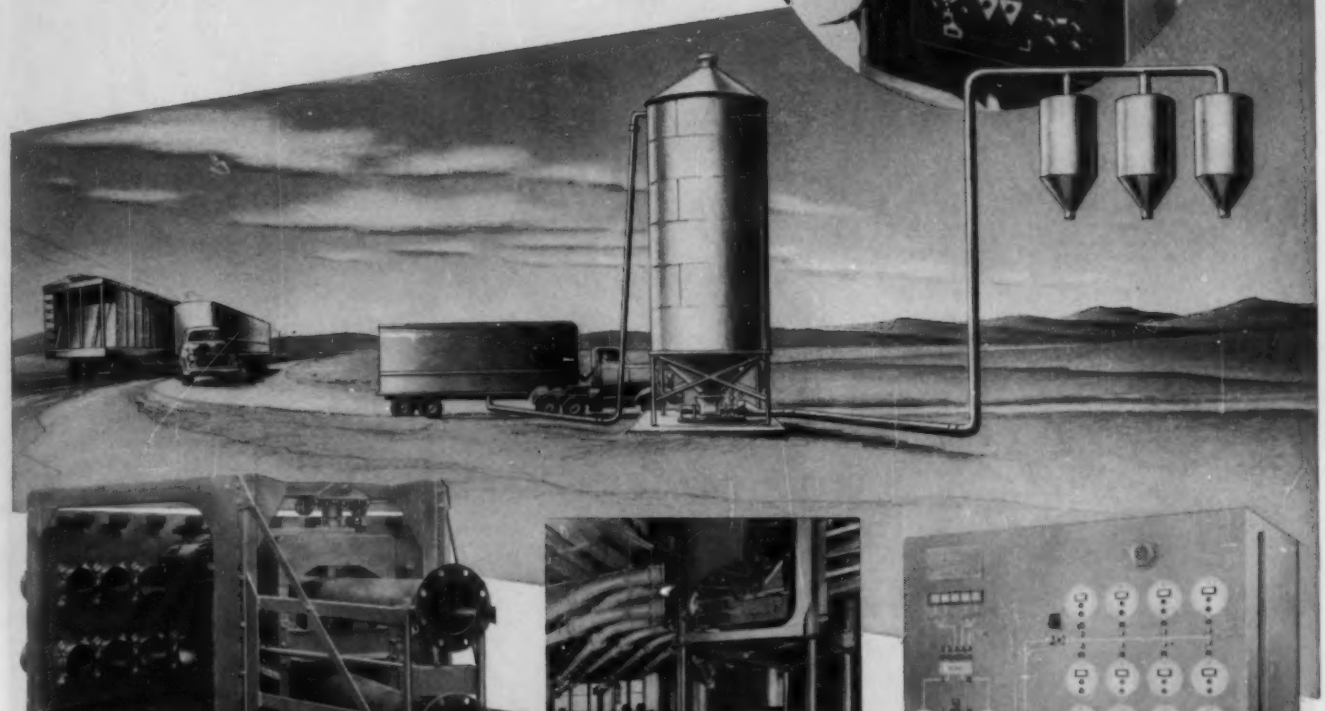


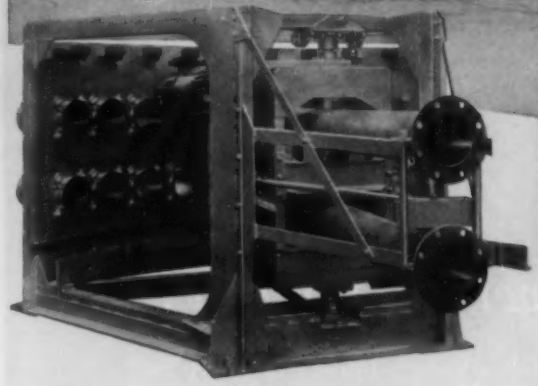
Bothered by a tough holding problem? Then let us show you how Erickson mandrels speed production, lower grinding or inspection costs. Write for Catalog K.

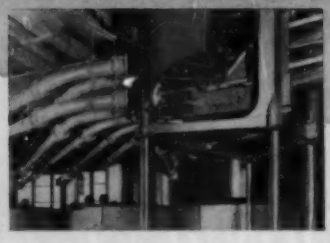
ONE SOURCE OF SUPPLY:

Controls Included

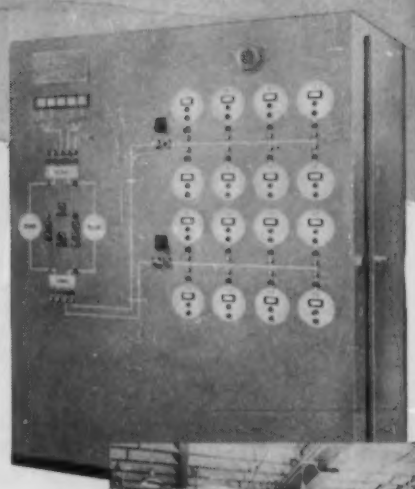


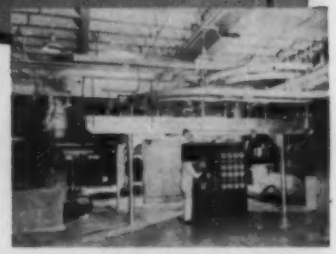






Eight-way duplex-motorized pipe-line switch. Distributes fine and granular materials to eight bins. Eight lower tubes carry material stream to bins; eight upper tubes, dust return stream to collector.





Airveyor control board with indicator lights. Simple push-button operation enables one man to remote-control two Airveyor systems from a central location.

Automatic control is an important feature of an integrated system for handling dry pulverized and granular materials. When you select a Fuller conveying system, Fuller-built automatic controls and motorized pipe-line switches for stream diversion can be included. No need to search for another supplier of control equipment to direct flow of material throughout all in-plant operations. Lights on the Fuller panel indicate routing of material, as well as full or empty bins. There is no limit to the number of points to be served . . . motorized pipe-line switches can be had for vacuum or pressure systems, or a combination of both. Write for details.

FULLER COMPANY
GENERAL AMERICAN

3414
G-129

Fuller
pioneers in harnessing AIR

FULLER COMPANY
162 Bridge St., Catasauqua, Pa.
A SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
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Circle 575 on Inquiry Card

ENGINEERS SERVING THE ROCK PRODUCTS INDUSTRY FOR OVER 30 YEARS

Peerless Cement Corporation
Port Huron, Michigan Plant

Is AUTOMATION the Answer . . . for You ?

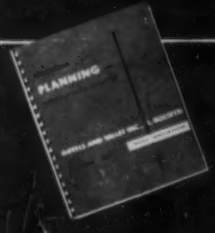
What yardstick can a management man use to evaluate Automation for his company?

Will it increase productivity, decrease costs, improve product quality—and to what degree? What capital investment is required, and how can it be amortized?

These are the questions which must be answered. They are the kind of problems which clients regularly bring to G & V for analysis and solution.

Giffels & Vallet's broad experience in the planning and engineering of production facilities . . . for many companies in many industries . . . at home and abroad . . . has brought about a practical insight and understanding of the complex problems involved . . . and their solution.

This is experience available to you—in the development of new plant facilities and modernization programs.



G & V services are discussed in a special Planning Brochure. A copy will be mailed on request.

INDUSTRIAL ENGINEERING DIVISION

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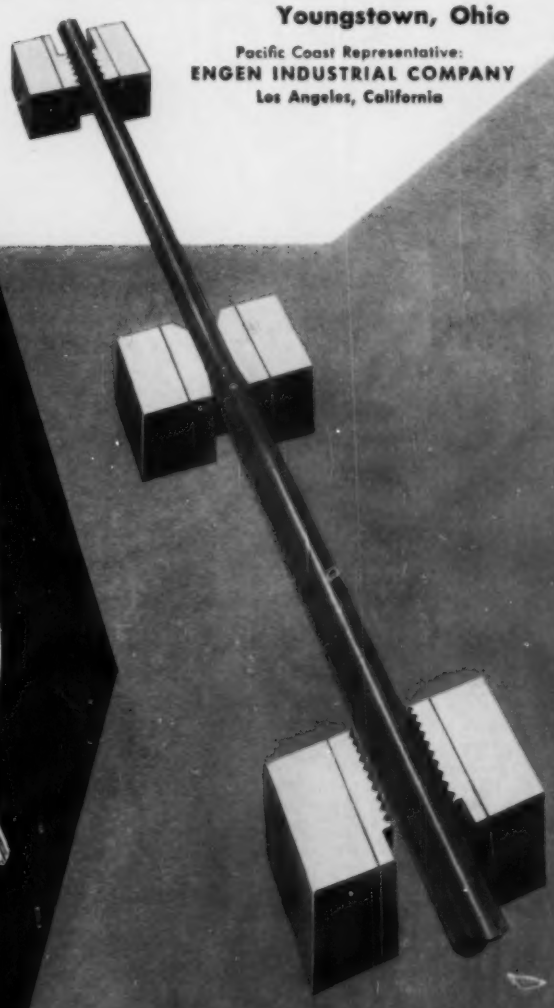

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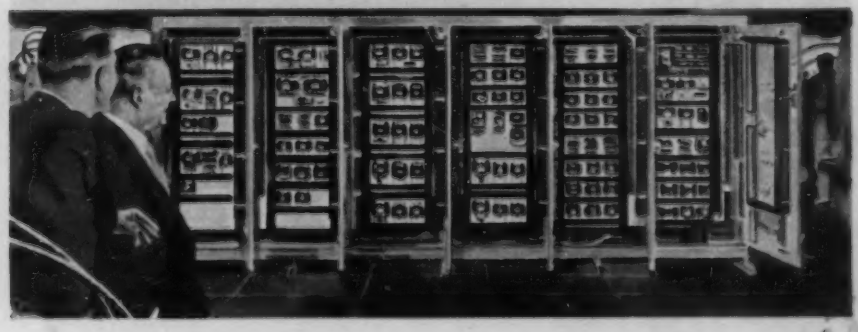

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